Alberta
Agriculture, Food and
Rural Development

1997 Annual Report

Forage Unit
Horticulture/Apiculture Unit
New Crop Development Unit

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Report of the Director

T.R. Krahn

The Crop Diversification Centres North and South (CDCN and CDCS) are research and development units of Alberta Agriculture, Food and Rural Development's Plant Industry Division. Staff conduct applied research, extension and development programs working cooperatively with other research organizations. The Centres' mandate of crop diversification and industry development is achieved by maintaining close and active working relationships with industry organizations and commodity groups.

This annual report covers the activities of staff in the Horticulture/Apiculture, New Crop Development, Forage Units located at CDCN and CDCS.

The Horticulture/Apiculture Unit is responsible for all horticulture/apiculture commodity based programs including: apiculture, fruit crops, greenhouse crops, nursery crops, potatoes and vegetable crops. The Unit also manages programs in plant pathology, entomology, micropropagation and market development, with specific responsibilities for Dutch Elm Disease and Farmers' Markets. This unit provides administrative, farm and equipment repair support to the New Crop Development Unit and the Forage Unit.

The New Crop Development Unit is responsible for special crop development, plant pathology, weed science, post harvest technology, food science and soil and water agronomy. This unit provides plant pathology, weed science, post harvest technology, food science and soil & water agronomy support to the Horticulture/Apiculture Unit and the Forage Unit.

The Forage Unit is involved with research and industry development related to grass seed production.

The Agroforestry Unit at CDCN was privatized. Effective April 1, 1997, Marketland, a private corporation with head offices at Bowden, Alberta took charge of the program. Marketland has a five-year agreement with Alberta Public Works Supply and Services to lease storage and working space at CDCN.

Staff of the Horticulture/Apiculture Unit continued their active involvement with the Alberta Horticultural Congress by serving on organizational committees and acting as resource speakers. Staff was also actively involved with the Alberta Potato Research Association, the Pulses, Vegetables and other crop committees of the Alberta Agriculture Research Institute, the Canadian Horticultural Council and several departmental product teams. Successful field days were hosted at both CDCN and CDCS. At CDCN large crowds attended the special crops field day seeking information about crop diversification. Vegetable growers who attended the field day at CDCS were able to review new production and agronomic management techniques.

Budget reductions continued to impact the operations of both Centres. Additional efforts were focused on obtaining outside funding to assist with operations. In this connection funding was received from Alberta Agricultural Research Institute (AARI) Direct Funding Program, AARI Matching Grants Program, Alberta Market Gardeners Association, Potato Development Inc., Chemical Companies and other industry organizations.

Privatization of the Agroforestry Unit resulted in a number of staff changes. Brendan Casement, Unit Leader retired after 26 years of service with Alberta Agriculture Food and Rural Development. Brian Brenneman, Helen Rekrut and Rulie Bok-Visscher had their employment terminated. Simone Dalpé was transferred to Fruit Crops Technologist position at CDCS and Crystal Moore was transferred to the Horticulture/Apiculture Unit at CDCN. Other staff changes are identified in program reports.

Organizational effectiveness was addressed at both Centres in 1997, through a series of staff consultations. These discussions resulted in the development of a long range development plan at CDCN and a greater ongoing effort to promote communications between the Centres at all levels.

This annual report is prepared as a summary of ongoing research and technology transfer programs at the Centres. More information on any program area, including detailed research reports, is available on request.

Forage Unit

H. Najda and A. Kruger

The forage crops program at the Crop Diversification Centre South (CDCS) is part of the Forage Unit administered through the Lacombe Research Centre. The program conducts research to provide up-to-date information on traditional forage crops and grass seed production. New crop varieties from universities, research agencies and private industry in Canada, the United States and Europe are tested. As well, a small component of the program conducts cereal and oilseed testing.

Research involving 100 irrigated and dryland trials were conducted at various locations in southern Alberta including sites at the CDCS, Brooks, the CDCS Substation at Bow Island, Standard and producer fields near Tilley and Lomond, Alberta.

Several trials were conducted in cooperation with other research institutions and agencies. These include the Agriculture and Agri-Food Canada Research Stations (AAFC) at Swift Current (triticale coop) and Lethbridge (perennial cereal rye), and the Field Crop Development Centre (FCDC), Alberta Agriculture Food and Rural Development (AAFRD) at Lacombe (forages, cereals and oilseeds).

The Forage Crops Agronomist provides service to other AAFRD staff and to producer and commodity organizations. Details of research trials are presented in *Field Crops Cultural and Cultivar Trials, 1997*, CDC-S Pamphlet 98-9.

Research Projects

Perennial Forage Crop Studies

Perennial forage cultivar testing

This was the seventh production year of this province-wide program evaluating perennial forage species and varieties funded by AAFRD and coordinated by the Forage Unit, Lacombe Research Centre. Species tested include alfalfa, bromegrass, the wheatgrasses, timothy and orchard grass. The forage crops program, at CDCS, is responsible for conducting trials at three dryland (Bow Island, Brooks and Standard) and two irrigated (Bow Island and Brooks) sites. We also compile and analyse data from all the provincial sites and prepare the annual report for the Alberta Forage Variety Committee of the Alberta Forage Council. This program provides data that allows producers to base crop decisions from a selection of a wide range of forage varieties tested. Data have indicated that there are significant differences in variety performance from one area of the province to another. Results of the trials are now available to the producer in the updated Agrifax pamphlet *Varieties of Perennial Hay and Pasture Crops for Alberta*. Agdex 120/32. As well, this information is available on the Internet at the AAFRD site: http://www.agric.gov.ab.ca

The Western Forage Testing (WFT) program was initiated in 1995. This is a tri-province (Alberta, Saskatchewan and Manitoba) cooperative venture which tests forage varieties for registration purposes. Once the program is underway, information generated will provide a basis for registration and in most cases, enough location years to provide data for particular agro-climatic areas. This efficiency will eliminate a minimum of four years testing over previous testing programs.

Perennial forage seed production under irrigation

This has become a major area of research in southern Alberta. Many seed companies from the United States and Europe are now contracting production acres in Alberta under irrigation. Adaptability and agronomy trials on Kentucky bluegrass, tall fescue, fine-leaved fescue and perennial ryegrass were conducted at Brooks and Bow Island. The increase of contracted seed production acres in southern Alberta has made this program an important source of information for producers already growing grass seed and those considering becoming grass seed producers.

Cereal and Oilseed Cultivar Evaluation

Cereal and oilseed regional tests

Trials coordinated by the Cereals and Oilseeds Unit at the FCDC at Lacombe and funded by AAFRD are used to evaluate all currently used cultivars, new cultivars, and breeding lines of hard red spring wheat, durum wheat, utility wheat, barley, oats, triticale, flax, and canola. The CDCS is responsible for an irrigated site at Brooks. Information from these trials conducted at sites province-wide is used by the Cereal and Oilseed Advisory Committee to annually update the factsheet *Varieties of Cereal and Oilseed Crops for Alberta* Agdex 100/132.

Other cereal trials

The CDCS cooperates with the Cereals and Oilseeds Unit at the FCDC at Lacombe, in their breeding programs for two-row and six-row barley, semi-dwarf barley, triticale, winter triticale, and winter wheat. The progeny and advanced line tests provide agronomic data used for the registration of varieties suitable for irrigated areas. Triticale grain trials are conducted under the Prairie Registration Recommending Committee on Grain Testing program, which is coordinated by the AAFC Research Station at Swift Current, Saskatchewan.

Technology Transfer Services

The program leader provides extension service to growers and industry personnel. In 1997, presentations were made at several industry and producer meetings and provincial advisory committees. Two scientific papers were presented at the XVIII International Grasslands Congress in Saskatoon. Two information pamphlets on forage variety performance were updated.

The program leader participated on the Forage Product Team, the Alberta Forage Variety Committee, the Cereal and Oilseed Testing Committee, the Forage Association Grant Committee, the Alberta Alfalfa Seed Committee, the Western Grass Seed Testing Committee, the Western Forage Testing Committee, the Agriculture Technology Advisory Committee of the Lethbridge Community College and the board of the Chinook Applied Research Association. The program leader also participated in seed judging for the North American Seed Fair held at Ag-Expo, Lethbridge.

Horticulture/Apiculture Unit

Alberta Dutch Elm Disease Initiative

J. Feddes-Calpas

Dutch Elm Disease (DED) is a deadly disease caused by the fungus *Ophiostoma ulmi* that clogs the elm tree's water conducting system, causing its leaves to wilt and the tree to die, usually within one or two seasons. The fungus which affects all species of elm is spread mainly from one tree to another by two species of insect vectors, the smaller European elm bark beetle (SEEBB) (*Scolytus multistriatus*) and the native elm bark beetle (NEBB) (*Hylurgopinus rufipes).* These two beetles breed in dead and dying elm trees. Once pupated, adult beetles leave their brood gallery and fly to healthy elms to feed thus transporting the fungus on their bodies from one tree to the next.

DED was first identified in Holland and northern France in 1919. The first instances of the disease in North America were identified in Ohio in 1930, since then the fungus has destroyed millions of elm across this continent. The first Canadian infection was identified in Richelieu County, Quebec in 1944. In Quebec the DED fungus had killed between 600,000 and 700,000 elm trees over an area of 24,800 square miles in 15 years.

Southern Manitoba has been battling the disease since 1975. Outbreaks were linked to campers carrying infected elm firewood from infected areas outside the province. From 1975-1991, the City of Winnipeg lost 34 percent (100,000 trees) of their elm inventory. Saskatchewan DED survey results in 1997 showed sixteen communities in the south eastern section of the province infected with the disease. The NEBB is the main DED vector in Saskatchewan and Manitoba. No evidence of DED has been detected in British Columbia even though large numbers of SEEBB are present in the interior the province.

Great Falls, Montana has been battling DED since 1987. With no effective response plan to DED in place, the city lost 80 percent of their elm trees between 1987-1995. Had a DED management program been in place before the disease struck, the city could have saved $160,447 per year over that eight year period.

Native stands of elms are found along the river beds in Manitoba and Saskatchewan but in Alberta, Montana, and British Columbia they are largely confined to urban and rural landscapes.

DED is distributed over most of the native range of American elm in Canada. Alberta has the largest DED-free stands of American elms in the world.

The destructive nature of DED and the threat to American elms in Alberta, motivated Alberta Agriculture Food and Rural Development (AAFRD), plant pathologists and entomologists to form the DED Action Committee in 1976. It was recommended at this time that elm plantings be reduced. The cooperation of Agriculture Canada's Plant Quarantine Division reduced the risk of importing diseased elm nursery stock the into Alberta. In 1978 the DED pathogen and its beetle vectors were included under the Alberta Agricultural Pests Act.

In 1988 a DED network was developed through the efforts of AAFRD. The network was made up of federal and provincial governments, private industry and special interest groups. At this time, the DED Action Committee was able to get firewood containment units sponsored by the cities of Lethbridge, Medicine Hat, Calgary, Red Deer, and by Alberta Agriculture. These units were placed at the four ports of entry, Wild Horse, Coutts, Carway and Chief Mountain. They were to hold the wood that had been confiscated by Canada Customs Staff until it could be properly disposed of.

Before 1988, Alberta Environmental Centre and the Alberta Special Crops and Horticultural Research Centre (now CDCS) monitored for the elm bark beetles using pheromone-baited sticky traps and elm trap logs at the ports of entry and strategic points along Alberta-Saskatchewan borders. The network encouraged major cities including Lethbridge, Medicine Hat, Calgary, Red Deer and Edmonton to fund and post their own traps. By having the city's carry out their own monitoring key personnel in City Parks Departments would be alerted to the introduction of DED if any beetles were found. Early detection would enable the identification, containment and elimination of any infection before DED could get permanently established. There was also an emphasis on increasing public awareness. In 1992,

an Alberta video, "When the Last Leaves Fall" was produced.

February 26, 1993 the Society to Prevent Dutch Elm Disease (STOPDED) a nonprofit organization, was formed. Its goal is the preservation and protection of Alberta's elm trees. The formation of this society makes obtaining financial support easier as well as managing future DED problems in the province.

Alberta Agriculture, Food and Rural Development (AAFRD) approved funding for a Dutch Elm Disease Initiative (DEDI) in June of 1993. The primary focus of this program was to increase public awareness of the threat that DED poses to American elms in Alberta and to advocate steps that should be taken to minimize the risk of introducing DED. The Crop Diversification Centre South (CDCS) administers the operation of the DED Initiative.

The initiative consists of seven programs:

1. **DED/Bark Beetle Survey**. This is done to determine if Dutch elm disease (*Ophiostoma ulmi*) and/or its vectors, the smaller European bark beetle (*Scolytus multistriatus*) and the native elm bark beetle (*Hylurgopinus rufipes*) are present in Alberta.

2. **Site Specific American Elm Inventory**. To estimate the geographical distribution, populations and value of American elms (*Ulmus americana*) in Alberta. A site specific elm inventory supplies the basic information necessary for an effective management program should DED appear in Alberta. The information will identify areas where intensive surveillance is necessary due to the number and/or condition of the elm trees.
3. **Firewood Confiscation Program**. To ensure that the firewood confiscation program conducted jointly by Alberta Agriculture and Canada Customs operates in an efficient manner.
4. **Public Awareness**. To heighten public awareness of the threat of DED to elms in Alberta and to promote steps that should be taken to prevent its introduction.
5. **DED Response Plan**. To develop and update an action response plan to help Albertans cope with DED, if and when it is introduced.
6. **Highway Signage Program**. To upgrade highway signage alerting travellers to the dangers of introducing DED and/or its beetle vectors into Alberta on infested elm firewood, elm trees, etc.
7. **Interprovincial Cooperation**. To encourage more interprovincial cooperation in the control of DED.

Since the initiative began in 1993, a number of projects have been accomplished. Additional firewood drop of bins have been placed at Travel Alberta Information Centres in Lloydminster, Walsh, Crowsnest Pass, and at Del Bonita and Aden ports-of-entry. All the Alberta-Montana ports-of-entry confiscate firewood from travellers and place it in these bins.

Border signage has been installed advising in-coming motorists not to bring firewood into Alberta and thanking out-going motorists for not bringing firewood in. There is also signage instructing people to drop off their firewood at the bins at Lloydminster, Crowsnest Pass and Walsh. Ten crossing points on the Alberta-Saskatchewan border are posted, five on the Alberta-Montana borders and one Alberta-British Columbia crossing point at Crowsnest Pass.

In 1997, approximately 400 locations throughout the province were monitored for the NEBB and the SEEBB, 130 of these locations were taken care of by the initiative with the remainder being the municipalities responsibility. Location and visitation were the main factors in choosing the monitoring sites. Monitored locations are provincial parks and recreational areas, smaller municipalities, some nurseries, all the Montana-Alberta ports-of-entry, and some Alberta-Saskatchewan and British Columbia ports-of-entry. Traps setup by the initiative are put in place May 1 and replaced again in mid-July. A sticky trap and an elm trap log is placed at each location. Since the SEEBB were detected in Vauxhall the previous year, traps were replaced monthly and inspected. All traps were inspected for the presence of the NEBB and the SEEBB.

St. Albert found SEEBB in 1995-1996 and Vauxhall in 1996. In 1997, SEEBB have been found for the fourth year in Calgary and the third year in Edmonton. Four SEEBB in three separate locations in Edmonton were found in the August-September traps. Calgary found one SEEBB in a May trap and then none until the August-September trap when thirty SEEBB's were found. Four SEEBB's in one trap were found in High River for the first time this year.

In March of 1997, STOPDED received funding from Human Resources Development Canada (HRDC), to provide new and sustainable employment opportunities

within STOPDED's Prevention Program. As a result of this funding, STOPDED has hired personnel on a province wide basis. STOPDED employees will be responsible for taking elm inventories, recording the condition and size of each tree and increasing public awareness in all municipalities.

A province-wide plan to inventory elm trees has been developed. The province has been divided into regions. Each of the five larger cities, including smaller municipalities directly around them, make up a region with the remainder of the province making up the sixth. Using the HRDC funding, each region is to hire personnel and complete elm inventories and perform public awareness in all the municipalities in their area. STOPDED has hired three two-persons crews to complete the sixth region. AAFRD contribution to this program is provision for the three crews, guidance, transportation and any other expenses incurred while working. Material for public awareness is supplied to all the regions. Municipal plantings of elms range from 10 to 50 percent of the overall tree plantings, often with comparable numbers growing on private lots.

Public awareness has been increased by: DED public announcements, articles placed in newspapers, a DED advertisement in the Alberta campground guide, poster and brochure distribution in all Travel Alberta Information Centres, and through public announcements on television and radio. A provincial DED brochure has been completed to be used throughout the province. STOPDED has been able to have a new fifteen minute education video "The Last Stand" produced in 1997 with money raised from fund raising. A broadcast version was also produced and aired on television.

Public concern for DED is growing in Alberta. A provincial hotline has been set up based out of CDCS. All the larger cities also have their own DED hotlines. All hotlines have been extensively used. Any reports of trees with potential DED symptoms have been inspected and if necessary, samples have been taken and submitted for fungal culturing.

A DED response plan has been completed providing an outline of the responsibilities of all province and municipality government agencies if DED or the vectors should appear within the province. It also details methods of implementing an effective prevention program in municipalities. All municipalities are being encouraged to start a DED prevention program.

Apiculture Program

K. Tuckey and D. Colter

The apiculture section of Alberta Agriculture, Food and Rural Development provides extension and regulatory service to the beekeeping industry of Alberta. Offices are maintained in Edmonton and Falher.

Apiculture registrations 1997

The Alberta Bee Act requires people who own and possess honey bees or beekeeping equipment in Alberta to register, annually, the number of colonies they own and the municipalities in which their bees are located (Tables 1, 2 and 3). The large number of beekeepers shown in Regions 2 and 4 reflects, in part, the number of hobbyist beekeepers living in Calgary and Edmonton.

Table 1: Number of Beekeepers and Colonies

Region*	1996		1997***	
	Beekeepers	Colonies	Beekeepers	Colonies
NR**	4	1,638	3	1,602
1	72	41,448	66	42,565
2	147	7,356	132	9,398
3	101	20,006	92	22,903
4	269	44,874	250	47,663
5	111	49,113	111	49,326
Total	704	164,435	654	173,457

* Region as established by Alberta Agriculture, Food & Rural Development
** NR non-resident beekeepers who operate colonies in Alberta
*** as of December 31, 1997

Table 2: Number of Beekeepers - by Region and Size of Operation

Colonies operated	Number of beekeepers per region* 1997***						
	NR**	1	2	3	4	5	Total
0	0	9	42	19	62	19	144
1-50	1	35	73	46	130	34	319
51-600	1	12	14	15	37	37	116
601+	1	10	3	12	21	28	75
Total	3	66	132	92	250	111	654

* Region as established by Alberta Agriculture, Food and Rural Development
** NR means non-resident beekeepers who operate colonies in Alberta
*** as of December 31, 1997

Table 3: Bee Colonies Operated - by Region and Size of Operation

Size of operation	Number of colonies per region* 1997**						
	NR**	1	2	3	4	5	Total
1-50	2	331	813	449	1,180	304	3,079
51-100	100	200	147	57	1,153	886	2,543
101-200	-	465	403	575	595	1,758	3,796
201-600	-	1,964	3,335	3,934	7,508	5,792	22,533
601-1250	-	3,275	1,200	4,565	12,577	15,936	37,553
1251-2000	1,500	-	3,500	8,773	-	7,450	21,223
>2000	-	36,330	-	4,550	24,650	17,200	82,730
Total	1,602	42,565	9,398	22,903	47,663	49,326	137,457

*Region as established by Alberta Agriculture, Food and Rural Development
** NR means non-resident beekeepers who operate colonies in Alberta
*** as of December 31, 1997

A new Bee Act was passed in 1995, and it, along with its new regulation, was proclaimed in February 1997. The two major changes are that beekeepers are no longer required to give the legal land description for each of their beeyards and permits are not required to sell bees or equipment.

Economics of beekeeping

The price of raw bulk honey reached a record high of about $1.25/lb in 1996. By the end of the 1997 extracting season the price had decreased to $1.05/lb with a few sales being reported at just below $1.00. There was an early movement of honey into the export market, particularly to Europe.

The demands of the hybrid canola seed production industry in southern Alberta continue to exercise a major influence on Alberta beekeeping. This is reflected in Table 1, which shows a small number of beekeepers and a very large number of colonies in Region 1. The rental rate per colony increased for the season to reflect the recent improvements in honey prices. Even though the seed companies are also using leafcutter bees it appears that there will be a need for even more colonies of honey bees in 1998.

Alberta honey production 1997

The 1997 crop year was very similar to the previous two years. Once again some Alberta beekeepers reported extensive wintering losses — attributed to tracheal mites, severe cold weather in March and failing queens. The difficult spring weather hindered beekeepers' efforts to replace winter losses. However, by the time the honey flow was due, the colony strength was good and moisture supplies across the province were adequate.

In most areas of the province the honey flow started well but a spell of hot dry weather in early August severely reduced the nectar flow. All parts of the province experienced disappointing honey crops. Only a few beekeepers reported very good crops in 1997. The average 1997 honey crop is estimated to be 125 pounds of honey per producing colony — up 10 pounds from 1996 but still about 15 pounds below the long term provincial average honey crop.

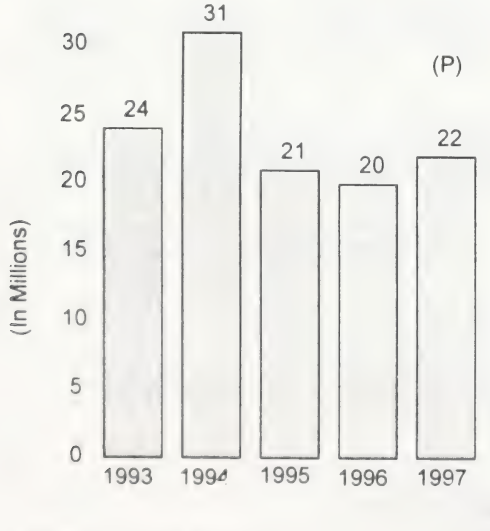

Figure 1: Alberta Honey Production (Millions of Pounds)

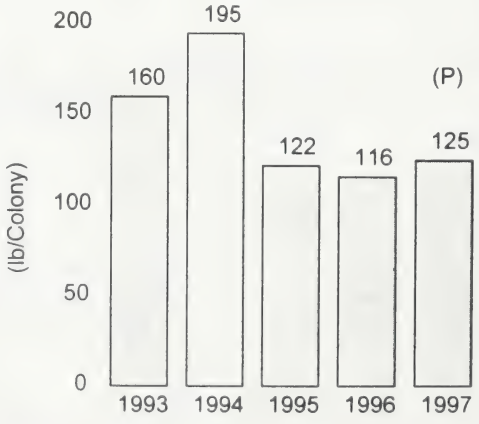

Figure 2: Alberta Average Honey Yield (lb/Colony)

Apiculture inspections and surveys

As varroa mites are found in more beekeeping operations, beekeepers are becoming more aware of the need to test their own bees for the presence of parasitic mites. The original Alberta varroa mite findings (1993 & 1994) were in operations that received honey bees directly from British Columbia. Since 1995 varroa mites have been found in beekeeping operations that were adjacent to bees from British Columbia but which did not directly have bees from British Columbia. This spread continued in 1997.

By the end of 1997 varroa mites had been identified in 40 beekeeping operations in 38 rural Alberta municipalities. Those 40 beekeepers operate approximately 69,000 colonies. However, not all bee colonies in each of those operations or municipalities, nor even most of them, are positive for varroa. Varroa mites have been identified all through the Peace region, and widely around Edmonton and south of Calgary. Varroa has not yet been identified around Red Deer or in the St. Paul area.

In order to enable movement, varroa checks were made on all operations moving bees to British Columbia for the winter. In addition, a survey was made of beekeeping operations adjacent to previous varroa finds. Varroa were newly identified in 13 beekeeping operations during 1997. In most cases the levels of infestation appeared to be quite low.

Most hive inspections carried out were at the request of owners — either to facilitate the sale of equipment or because the beekeeper perceived a problem. Colonies and/or equipment in eight beekeeping operations were examined specifically for brood diseases. American Foulbrood (a bacterial disease) was detected in three of the operations but the inspections were not widespread enough to give an indication of the health of the whole industry. However, it is clear that beekeepers who do not monitor and control this disease can have a problem develop quickly.

Interprovincial movement of honey bees

A permit is required from Alberta Agriculture, Food and Rural Development to move Canadian honey bees into Alberta. Also regulations require that all bees coming into Alberta from provinces known to have varroa mites must be treated for the control of the mite prior to entry. A number of shipments were checked to confirm compliance with this regulation.

During the spring of 1997 permits were issued for the importation of 9,200 colony units (packages, nucleus or full size colonies) into Alberta from British Columbia and Saskatchewan. In the fall 13,000 colony units moved to British Columbia for the winter season. This represents a 30 percent increase over last year in the number of bees moving to British Columbia for the winter. This is partly the result of the continued advance of varroa mites. Once beekeeping operations are infested with varroa, there is less to lose by bringing in bees that have been exposed to the mite. The beekeepers can then take advantage of the mild southern British Columbia winters with their varroa positive bees — they are already committed to the expense of treating all of their colonies to prevent loss from the mites.

Overwintering honey bees

Alberta beekeepers continue to winter their honey bees in British Columbia, in ventilation controlled buildings or outdoors. Table 4 provides wintering statistics for recent years.

This year, for the first time, beekeepers were requested to provide information on whether their bees were wintered indoors or outdoors. The wintering success rates for the 1996/97 winter were virtually the same for both wintering methods.

Table 4: Winter Survival of Honey Bee Colonies

Year	Colonies operated	Units into winter	% Survival
1992-1993	157,000	147,000	83
1993-1994	157,000	149,000	81
1994-1995	165,000	154,000	80
1995-1996	173,000	167,000	69
1996-1997	163,000	131,000	81
1997-1998	177,000#	170,000#	N/A

estimate

Government Programs

Agriculture Financial Services Corporation - Insurance Division - This joint Federal, Provincial and industry program continued to protect 27 Alberta beekeepers from losses due to poor honey yields compared to their long-term average yield. The poor honey crop of 1997 resulted in 11 loss claims for $919,000 compared to 8 claims for $290,000 in 1996.

Net Income Stabilization Account (NISA) - This joint Federal, Provincial and industry program, which assists farmers to provide long term monetary security for their farms, was first offered to beekeepers in the 1992 taxation year. During the 1995 taxation year 89 beekeepers made contributions based on net sales of $11.8. In 1996 71 beekeepers made contributions on $6.4 million.

Farming For The Future and On Farm Demonstration Program - These provincially funded programs assist in basic and applied research and in proving the worth of new ideas on the farm. From time to time beekeeper related subjects are tested. During 1997 a project studied analysis methods for honey and wax purity to look for ways to detect a particular pesticide.

Technology Transfer Services

Both apiculturists provide monthly articles to the *Bee News*, published by the Alberta Beekeepers' Association. Talks were given to the annual meeting of the Alberta Beekeepers' Association and to local beekeepers meetings upon request.

A large part of any summer office time is used providing advice to members of the public who have called with "honey bee" problems. At least half the time the insects involved are bumble bees or some type of wasp.

Beekeepers and potential beekeepers consult the apiculturists on a regular basis requesting information or service.

Interpreting the beekeeping industry to other segments of the government, and to industry, is an important facet of the duties of this section.

Fruit Crops Program

L.G. Hausher and S. Dalpé

The fruit crops program serves the developing and expanding berry and bush fruit industry in Alberta through applied research, development, and technology transfer activities. Strawberries, raspberries, saskatoons and black currants are the primary crops studied, although other fruit crops are evaluated for their commercial potential. Extension and development activities are directed to producers and producer organizations including the Alberta Market Gardeners Association (AMGA) and Fruit Growers Society of Alberta (FGSA).

Research Projects

Details on cultivar evaluation and cultural trials are the reported in CDCS Pamphlet Series *Fruit Crop Trials 98-6*. This trial report also includes results of strawberry, raspberry and saskatoon trials conducted at the CDCN.

Strawberries

Junebearing strawberry timing of winter mulch application

Approximately 15 cm of wheat straw mulch was applied to treatment rows at 6 to7 day intervals from October 21 to November 25, 1996. Mulch was removed from all treatment rows April 24, 1997. Plants were harvested twice per week from June 26 to July 31. No significant yield differences were observed between treatment dates with either of the cultivars evaluated Kent or Glooscap.

Junebearing strawberry cultivar evaluation

Four Junebearing cultivars, Kent, Glooscap, Cavendish and Honeoye were established and deblossomed in 1996. Rows were overwintered with 15 cm of wheat straw. The replicated trial was conducted at both CDCS and CDCN. Plants were harvested from June 26 to July 31 at Brooks and July 4 to 28 at Edmonton. Although the cultivar Kent was the top producer at the Brooks site, it only significantly outproduced Honeoye. The cultivars Glooscap and Cavendish significantly out produced Honeoye at the Edmonton site.

Nova Scotia Junebearing strawberry selection evaluation

Four strawberry cultivars and five advanced selections all from Agriculture Canada, Kentville, NS were established in 1996 in a replicated trial, and overwintered with straw mulch. Harvests were carried out twice a week from June 26 to July 31. The three standard cultivars Cavendish, Glooscap and Kent outproduced all numbered selections and the newly released cultivar Mira.

Quebec Junebearing strawberry cultivar and selection observation

Two strawberry cultivars and six advanced selections from Agriculture Canada, St. Jean-sur-Richelieu, Quebec were established in 1996 in an observational trial. One to ten plants were established of each, deblossomed and overwintered with straw mulch. Harvests were carried out twice a week from June 26 to July 31. Three of the advanced selections out yielded the standard cultivar Kent. The Quebec cultivar Oka and Chambly out yielded the standard cultivar Glooscap but were out produced by the standard Kent.

Day-neutral strawberry cultivar evaluation - fruiting enhancement

Three day-neutral cultivars, Fern, Tristar, and Seascape were established in a replicated trial at CDCS and CDCN. One-half of each row was covered with a spunbonded row cover (Kimberly Farms .6 oz/yd^2), at planting and removed six weeks later. Harvests were carried out twice a week from June 12 to October 2 at Brooks, and from July 4 to September 29 at Edmonton. Both total and marketable yields were recorded. The application of fibre row cover provided a marginal yield increase of Tristar' at the Brooks site, but did not increase yields of remaining two cultivars. Row cover application decreased yields of Seascape and Fern at the Edmonton site.

Evaluations of overwintered day-neutral strawberry cultivars

Four day-neutral cultivars, Evita, Tristar, Fern, and Seascape were established and harvested in 1996 then overwintered with straw mulch at both Edmonton and Brooks sites. Harvests were made twice a week, from June 16 to October 2 at Brooks and from June 23 to September 29 at Edmonton. The cultivar Fern was the top producing overwintered cultivar at Brooks and Tristar at Edmonton.

Raspberries

Floricane raspberry trellising and row width evaluation

Eight different trellis and row width treatments were evaluated on Boyne raspberry for a number of years. Row widths were evaluated were 15, 30 and 45 cm. Trellising was either all north, all south, both north and south, as well as a no-trellised standard.

Cane damage was extensive the winter of 1996-97, thus plants were not harvested in 1997. New growth was vigorous and the trial will be continued in 1998.

Primocane raspberry cultivar enhancement evaluation

Five cultivars of fallbearing raspberries; Summit, Autumn Bliss, Ruby, Red Wing and Heritage were established in 1990 as part of the North American Primocane Raspberry Genotype by Environment (G x E) Study. The study was completed in 1993. During the early spring of subsequent years canes are mowed to the ground. One-half of each row is covered with a thin (Kimberly Farms 20 g/m^2) fibre row cover in April and removed when growth reached approximately 30 cm.

Harvests were made twice a week from August 12 to October 2. The cultivar Autumn Bliss significantly out yielded all row covered cultivar rows.

The cultivars Autumn Bliss and Summit significantly out yielded remaining cultivars in control rows.

Fibre row cover increased yields of all cultivars except Ruby.

Primocane raspberry new cultivar enhancement

Three cultivars Red River, Double Delight, Fallbrook and one selection 8001 were evaluated with and without an early spring covering of fibre row cover similar to the previous trial. The row cover increased yields of Fallbrook but had a negative effect on yields of remaining cultivars.

Chokecherry/Pincherry cultivar evaluation

The following cultivars were established in 1993/94.

Chokecherries	Pincherries	
Goertz	Mary Liss	'Lee Black' Nanking Cherry
Garrington	Jumping Pound	
Robert (Lee Black)	Lee #3	
Lee 'Red'	Lee #4	
"Paul"	"Paul	
"BC"		

This was the first year of production from the chokecherries. The cultivar Garrington was the top producer.

Black Currant/Gooseberry cultivar evaluation

A number of new and older cultivars of both black currants and gooseberries were established in 1995, 1996 and 1997. Five new cultivars of black currants established in 1995 were harvested for yield in 1997. The cultivars Ben Alder and Ben Lomond produced yields exceeding 2.4 kg/bush.

Technology Transfer Services

Fruit Facts, a bulletin providing berry producers with up-to-date production and marketing information was published monthly. Articles were prepared regularly for the AMGA and for the FGSA newsletters. A commercial berry production school and a greenhouse strawberry workshop were conducted in Red Deer. A saskatoon workshop was presented in Edmonton. Assistance was given to the AMGA in the bulk ordering of strawberry plants for Alberta producers.

The fruit specialist continued as secretary of the Alberta Professional Horticultural Growers Congress and Foundation Society; the Alberta Horticultural Congress Foundation; The Horticultural Congress Planning Committee; The Alberta Society for Professional Horticultural Advancement; and the AMGA. Presentations were made to research, commodity, and advisory groups during the year. Assistance was provided in the planning and execution of the Alberta Horticultural Congress.

Financial assistance from the AMGA made it possible to attend the North American Strawberry Growers Association, the North American Bramble Growers Association, and the International Ribes Association Annual Meetings.

The fruit specialist responded to individual and commodity group requests for information.

Greenhouse Crops Program (Brooks)

J. Calpas, P. Coté and S. Graham

The greenhouse crops program serves southern Alberta's diverse greenhouse vegetable and floriculture industry by providing a comprehensive extension service and conducting applied greenhouse research. The program works in cooperation with the greenhouse crops program at the CDCN. Extension services include: providing crop management information and recommendations, diagnosis of crop disorders, fertilizer feed programs and plant tissue analysis interpretations. Program activities are directed towards individual growers and grower organizations such as the Alberta Greenhouse Growers Association.

Research Projects

Vegetable Crops

Sweet pepper cultivar trial

The purpose of this trial was to evaluate the performance of a number of sweet pepper cultivars under southern Alberta greenhouse growing conditions.

Thirteen greenhouse sweet pepper cultivars, from various seed sources were sown on October 15, 1996 in rockwool cubes, the seedlings were transplanted into rockwool blocks on October 22 and were planted out onto 20 litre sawdust (mixture of spruce and pine) bags in the greenhouse on November 15, 1996. Four repetitions of each cultivar were arranged in a randomized design in the greenhouse. Each repetition consisted of one sawdust bag with three plants per bag. The final planting density was 3.0 plants/m^2. All cultivars were blocky 3 to 4 lobed types, with the exception of LM 204 and Jetta which were long 3 to 4 lobed types. The cultivars examined in this trial were red and yellow cultivars.

The plants were grown following accepted commercial cultural practices. Insect pest control was accomplished exclusively through the use of biological control agents. Picking commenced on February 24, 1997, the crop was harvested two times per week, Mondays and Thursdays for 32 weeks. Data was collected on the yield and grade of the fruit.

The cultivar Robusto, from De Ruiter, a red cultivar produced the largest overall yield, 21.23 kg/m^2. The largest yielding yellow cultivar was DRP 3067, from De Ruiter, 18.15 kg/m^2. The lowest yielding cultivar was DRP 3139, a red cultivar from De Ruiter, 10.97 kg/m^2. The other cultivars tested were: Edison and Oberon from Enza Zaden, DRP 3155, DRP 3136 and DRP 3065 from De Ruiter, LM 204, Brupa and Jetta from Leen de Mos, and Bossanova and Mazurka from Rik Zwaan.

Evaluation of Two Commercial Clay Products on the Production of a Southern Alberta Greenhouse Sweet Pepper Crop and Spring Greenhouse Cucumber Crop

The purpose of this trial was to determine the effect of MinerALL Clay® (Oceanic Clay) and PyroClay®[3] on the yield of greenhouse sweet pepper and cucumbers.

Seven cultivars of greenhouse sweet pepper, from four seed sources were sown on October 15, 1996 in rockwool cubes, the seedlings were transplanted into rockwool blocks on October 22 and were planted out onto 20 litre sawdust (mixture of spruce and pine) bags in the greenhouse on November 15, 1996. Twelve plants of each cultivar were included in each of three treatments.

Flamingo and Aluco (Leen de Mos) cucumber seeds

were sown on January 15, 1997 in rockwool blocks and were planted out onto 20 litre sawdust (mixture of spruce and pine) bags in the greenhouse on February 3, 1997. Twenty plants of each cultivar were included in each of three treatments.

1. One kilogram of MinerALL Clay® was incorporated into 20 Litres of spruce and pine sawdust at time of filling the sawdust bags.
2. Fifty grams of PyroClay[3]® placed on the top of the rockwool blocks when the plants were set on the sawdust bags.
3. A control treatment consisting of seedlings in rockwool blocks without PyroClay[3]® and planted on sawdust bags without MinerALL Clay®.

Each treatment-pepper cultivar combination was replicated four times. Each treatment unit consisted of one sawdust bag with three plants per bag. The treatments were arranged in a randomized design. The final planting density was 3.0 plants/m^2.

Each treatment-cucumber cultivar combination was replicated ten times. Each treatment unit consisted of one sawdust bag with two plants per bag. The treatments were arranged in a randomized design. The final planting density was 1.8 plants/m^2.

The trial was grown following accepted commercial cultural practices. Insect pest control was accomplished exclusively through the use of biological control agents. Picking of peppers commenced on February 24, 1997 and was completed on October 10 , 1997. The crop was harvested two times per week, Mondays and Thursdays for 32 weeks. Data was collected on the yield and grade of the fruit.

Picking of cucumber fruit commenced on March 12, 1997 and was completed on July 4, 1997. The crop was picked three times per week, Mondays, Wednesdays and Fridays. Data was collected on the yield and grade of the harvested fruit.

The treatments of MinerALL Clay® and PyroClay[3]® did not improve yields of either sweet peppers or cucumbers.

Greenhouse Fall Crop Cucumber Cultivar Trial

The purpose of this trial was to determine the yield of a number of greenhouse powdery mildew tolerant cucumber cultivars grown as a fall crop.

The crop was seeded on July 2, 1997 in rockwool blocks and were planted out onto 20 litre sawdust (mixture of spruce and pine) bags in the greenhouse on August 15, 1997. Thirty plants of each cultivar were set out into the greenhouse at a final planting density was 1.8 plants/m^2. Each cultivar occupied a single row in the greenhouse.

The trial was grown following accepted commercial cultural practices and following the general guidelines supplied by the seed companies. Insect pest control was accomplished exclusively through the use of biological control agents. Picking commenced on August 15, 1997 and was completed on October 24, 1997, for a 10 week picking period. The crop was harvested three times per week, Mondays, Wednesdays and Fridays. Data was collected on the yield and grade of the harvested fruit.

Table 5. Mean yield of three powdery mildew resistant cucumber cultivars grown as a fall crop.

Cultivar	Seed Source	Total Marketable Yield Per Plant	Total Number of Mediums and Large Cucumbers per Plant
DRL8234	De Ruiter Seeds	12.12	15.35
Danora	Dæhnfeldt	13.39	18.68
LDR957063	Dæhnfeldt	14.40	18.90

Preliminary evaluation of "Ballistic", a natural food grade foliar feed product, and "Kelp Blend", a natural seed treatment, on the yield of a Southern Alberta fall Greenhouse cucumber crop

The increasing concern over the effect of conventional crop production practices on the environment has motivated producers to trial various alternative products in their production systems. These products tend to be described as being "all natural", "environmentally friendly" or even "certified organic". These descriptions are used to convey the message that these products have been developed using natural biological organisms, or very clean, close to nature, processes in order to set them apart from what would be considered as conventional fertilizer or pesticide products. The implication is that these products are better for crops and better for the environment. The expectation from the use of these products is that they will allow for continued high production, or even an increase in production, and could minimize the use of conventional crop production inputs.

Ballistic is one alternative product that is recommended as a foliar spray, primarily as a foliar feed to be mixed with a 9-18-9 food grade fertilizer prior to application. This spray combination has been used on field crops with some grower reports of marked increases in yield.

The Kelp Blend product is a biological blend of seaweed extracts and a number of different types of bacteria. The product has one reported use as a seed treatment.

There are currently no recommendations for use of these products on greenhouse crops.

The objective of this trial was to determine the effect of "Ballistic", a foliar applied food-grade fertilizer product and the effect of the "Kelp Blend" seed treatment, on the yield of a fall planted greenhouse cucumber crop.

Cucumber seeds (powdery mildew tolerant cultivar DRL8234, De Ruiter Seeds) were sown on July 2, 1997 in rockwool blocks and were planted out onto 20 litre sawdust (mixture of spruce and pine) bags in the greenhouse on August 15, 1997. Just prior to seeding, half the seed was subjected to a 15 minute soak in the Kelp Blend product, the other half of the seed was subjected to a 15 minute soak in distilled water and served as the control. Thirty two plants were included in each of four foliar feed spray treatments, with half of all the plants in each treatment having also been subjected to the kelp seed dip. Each foliar feed spray application was applied once, at pre-bloom, one week after the plants were set out into the greenhouse. The foliar feed sprays were applied to run-off.

The four foliar feed treatments were:

1. Ballistic spray - applied at the rate of 50 millilitres of Ballistic per 10 litres of distilled water.
2. 9-18-9 liquid fertilizer spray - applied at the rate of 27 millilitres per 10 litres of distilled water.
3. Combination spray of Ballistic and 9-18-9 - at the rate of 50 millilitres of Ballistic and 27 millilitres of 9-18-9 per 10 litres of distilled water.
4. Distilled water spray control.

Each spray - seed dip treatment combination was replicated eight times. Each replication consisted of one sawdust bag with two plants per bag. The treatments were arranged in a randomized design. The final planting density was 1.8 plants/m^2.

The trial was grown following accepted commercial cultural practices. Insect pest control was accomplished exclusively through the use of biological control agents. Picking commenced on August 15, 1997 and was completed on October 24, 1997, for a 10 week picking period. The crop was harvested three times per week, Mondays, Wednesdays and Fridays. Data was collected on the yield and grade of the harvested fruit.

There was no significant effect on yield due to any of the foliar feed treatments or to the Kelp Blend seed treatment in this trial.

Observations of the seedlings at time of transplanting from the rockwool plugs into the rockwool blocks indicated that the seedlings which had received the Kelp Blend seed treatment had a more well developed root system than the control seedlings. Once these cucumber plants were planted out into the greenhouse and began to bear fruit, they did not distinguish themselves from the control seedlings based on yield. As all the plants in the trial were on the same complete feed program any benefits that the plants may have received

from the Kelp Blend seed treatment could have been offset by the fertilizer feed program which constantly supplied nutrients to the plants at every watering.

To give a better assessment of any potential effects of the Kelp Blend seed treatments on the yield potential of greenhouse cucumbers, the product should be evaluated on cucumber plants growing under different fertilizer regimes, with some plants receiving considerably lower levels of fertilizer. Such a study was beyond the scope of this evaluation.

As there are currently no recommendations for the use of the Ballistic - (9-18-9) foliar feed spray combination on greenhouse crops the application rates used in this trial were similar to those used on crops in the field. Also, the foliar spray treatments were applied only once just prior to the onset of a 10 week picking period.

Again, due to the intensive nature of greenhouse crop production, the effect of any foliar feed application is likely to be minimal when compared to the effect of the fertilizer feed supplied to the plant root system. Further, more than just one application of the foliar sprays should be considered when a crop is continually yielding over a 10 week period. Weekly applications would be a good place to start.

More work is required in order to assess any effect that these products could have on the yield of greenhouse vegetable crops. It is likely that any benefits arising from the use of these products would first be seen when less intensive fertilizer feed programs are used. It still remains to be determined if the use of these products can maintain current commercial yield levels under conditions of less intensive fertilizer use.

Preliminary investigation into the potential of greenhouse scotch bonnet pepper production

The increasing consumer interest in hot peppers and hot sauces raises the question as to whether hot peppers represent an opportunity for crop diversification for Alberta greenhouse growers. Scotch bonnet peppers are one of the hottest types of peppers known and scotch bonnets can be found in various retail grocery stores in Alberta and there are Alberta processors who are making sauces from imported scotch bonnet peppers.

Information regarding scotch bonnet pepper culture and performance under southern Alberta greenhouse growing conditions is required in order to assess their potential for commercial greenhouse production. Scotch bonnet peppers are grown primarily in the Caribbean as a perennial crop. The plants develop into large bushes which are cultured for about three to four years.

The purpose of this trial was to gather preliminary production and performance information on the culture of scotch bonnet peppers on three different growing media under southern Alberta greenhouse growing conditions.

Scotch bonnet pepper plants were started from seed in rockwool plugs on approximately March 15, 1997. The seedlings were transplanted into rockwool cubes on approximately April 2, when they were 3 weeks old. The seedlings were planted out into the greenhouse onto either rockwool slabs, peat moss (pots) or spruce and pine sawdust (bags) at the end of April when the seedlings were 7 weeks old. There were two plants per twenty litres of planting media. The final planting density was 1 plant per 3.0 square metres. There were three rows of eight plants with one row dedicated to each of the growing media. The plants were on constant fertilizer feed following a standard sweet pepper fertilizer feed program. First pick was July 9, final pick was November 10 for a twenty week harvesting period.

Rockwool produced the largest yields, followed by sawdust and peat.

The plants quickly developed into large bushes with the onset of the high light period in June. The rows filled in, resulting in a solid mass of plants, making it difficult to work the crop. As with sweet peppers, some of the stems had to be supported with twine hanging from an overhead wire to prevent breakage of the stems due to the fruit load. The plants were not pruned or trained other than to provide the support to weak stems.

The plants were not adversely affected by high temperature as long as adequate water (15-20 percent over drain) was supplied. The crop was grown in an older glasshouse structure with seven foot gutters, and the temperature in this house rose to over 40°C for almost two straight weeks during the hottest period of the

summer. The plants did not show any signs of undue stress although growing the crop in a greenhouse with adequate cooling, keeping the temperature below 30°C, would certainly be preferable from a crop handling perspective.

The yield of the crop, about 1.67 kilograms per square metre. The plants in this trial were too vegetative to make a good greenhouse crop. It should be possible, through pruning and training techniques, to maintain high plant density and improve the structure of the crop in order to make it easier to work. Improving plant management should also establish a balance for optimum fruit production and should result in higher yields.

Timing of the crop to coincide with the schedule for sweet pepper production should also be investigated in order to maximize fruit production over the course of an entire season.

The results of this preliminary trial indicate that further work investigating the potential of greenhouse production of scotch bonnet peppers is warranted.

Fruit Crops

A Look At Greenhouse Strawberry Production

Interest in greenhouse strawberry culture has come from two sources; market gardeners who want to extend their strawberry production season by growing an early greenhouse strawberry crop, and greenhouse growers who are interested in opportunities for diversification. The window of opportunity for greenhouse strawberries is in May and June, just before the local field production starts to reach the market, and in November and December, after the local field production is finished and before imported strawberries are available.

Work on greenhouse strawberry production at CDCS was carried out in cooperation with the fruit crops program at CDCS and Lindbrook Farms Ltd., Tofield, Alberta. Both Junebearing and day neutral cultivars were evaluated as spring and fall crops on sawdust and peatmoss growing media. Plants were primarily grown on a complete feed program, constant feed, with a feed E.C. of 1.5 to 2.0 mmhos.

Yields were consistently higher in the crops grown on peat than those grown on sawdust. Sawdust is more well drained than peat and the strawberries grown in peat yielded twice as much as plants in sawdust. Sawdust appears to be too well drained for strawberry plants which prefer the better water holding capacity of a peat based growing media.

Optimal timing for the spring crop appears to be a mid-February planting of a Junebearing cultivar (i.e. Kent) with first pick anticipated about mid-May and last pick in late June. A target planting density of 3.0 to 4.0 plants per square foot was achieved at Lindbrook Farms by hanging peat-filled grow bags on six foot tall 'fence' supports which allowed for efficient use of vertical space to hang three rows of grow bags on each side of a single 'fence' row along the length of the greenhouse. More conventional double rows were used at CDCS with a resulting plant density of only 0.71 to 1 plant per square foot. Yield on the peat culture was about 116 grams per plant for Junebearers (Kent) with 10 weeks from planting the crowns to first pick with about 6 weeks picking. Day neutrals planted in February/March also began to yield after 10 weeks and picked for 14 weeks with yield ranging from 100 grams\plant (Tristar) to 200 grams/plant (Selva). The day neutrals would start picking in about early June and continued well in to August, however at this time the field crop was also in full production.

There was more difficulty with the fall crop. Firstly, the crowns had to be held in storage longer before planting out in early September, secondly, the plants tended to stay vegetative once in the greenhouse as temperatures often rose above 30°C resulting in a heat delay of the plants developing fruit buds (day neutrals). Thirdly, plants were developing during decreasing daylengths and even once they set fruit they had difficulty filling the fruit (day neutrals and June bearers). The greenhouse that the fall crop was grown in was only equipped with a mist cooling system, a pad and fan evaporative cooling system appears necessary for successful fall crop culture (at least in southern Alberta). There

was no appreciable yield from this fall crop.

Greenhouse strawberry production does not appear to offer a significant opportunity for diversification for greenhouse growers. Competition with local and imported field berry production for most of the year makes the crop relatively unattractive. Market gardeners may realize more success with greenhouse strawberry production as a supplement to their own field production, as a early spring greenhouse crop can command a better price and can establish the producer in the market in advance of the field berries. Fall crop production holds less promise as it requires even higher capital input for cooling systems and the yield potential appears to be less as the onset of fruit production is accompanied by lower light conditions.

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Greenhouse Crops Program (Edmonton)

M. Mirza, M. Younus, W. Chen and D. O'Hara

Industry, Changes And Trends

The greenhouse crops industry in central and northern Alberta registered steady growth during 1997. A 4000 sq. m. greenhouse facility in Lacombe growing roses in coco peat was closely monitored for any nutritional problems and the effectiveness of environmental control systems. It appeared that high gutters with ridge venting without mechanical ventilation worked reasonably well. This resulted in the completion of another 8000 sq. m. greenhouse to grow peppers and testing technologies like carbon dioxide recovery from boiler stack, central inflation of the greenhouse roof and biofiltration system for recycled irrigation water. Several growers installed new environmental control computers and some upgraded their computer capabilities.

One grower added 4000 sq. m. of greenhouse space to grow cut flowers. Bedding plants and tree seedling area also expanded. One important development was the privatization of the Pine Ridge Forest Nurseries in Smoky Lake. A group of Alberta growers took over this nursery and it is being now operated under the name Smoky Lake Forest Nursery. New greenhouse construction is a reflection of the stability of the industry.

Research Projects

Further studies with the germination and production of *Echinacea angustifolia*

In these studies the effect of seed surface sterilization, variable temperature, pregermination seed soaking, growing media and cold stratification were examined in many seed lots. In seed sterilization studies a 0.5 percent bleach was used for five minutes to surface sterilize *Echinacea angustifolia* seeds. The seeds were thoroughly rinsed 3 to 5 times with tap water after treating with bleach. Germination was carried out at 22°C under a light intensity of 40 watts/sq. m. This bleach treatment significantly reduced fungal infections and improved germination percentage by 14 to 18 percent in various seed lots as compared with control of water. Hydrogen peroxide treatment of 1.5 percent for 10 minutes significantly reduced fungal infection without increasing germination rates or percentages when compared to control.

In cold stratification studies, seeds were directly placed on pre-wetted peat lite media or rockwool propagation cubes of equal volume and were stratified at 4°C with continuous light exposure of 40 foot candles. The effect of cold stratification on germination was evaluated in relation to variable time intervals starting from 27 to 58 days. After that, germination tests were conducted in a statistically replicated design in the same plug or cube at 22°C and 24 hours of incandescent and fluorescent lights in a growth chamber at an intensity of 40 watts/sq. m. from 7 to 14 days. In all seed lots germination percentage improved significantly. Older seed lots of the same source showed comparatively lower percentage of germination. A detailed report is available under the title Germination of Echinacea, CDCN#97-GP-1.

Production of *Echinacea angustifolia* in containers under greenhouse conditions

Echinacea angustifolia was seeded in March and planted into various containers at the end of June to early July. The containers consisted of Styroblocks[R] 112 (105 ml), 91(130 ml), 77(170 ml), 60 (250 ml), 45 (350 ml), 28 (500 ml and 20 (700 ml). A commercial soilless growing medium was used to grow plants. Standard cultural practices were practiced. Plants were extracted from the cavities in September, October, November and December. Excess growing medium was gently removed and then roots were washed in cold water. The roots were placed on paper towel and allowed to dry out for 15 minutes so that there was no free water on the root surfaces and then the fresh weights were taken. Dry weights were taken after one month of air drying in a paper bag. All averages are from four replicates with 5 plants in each replicate. An analysis of the data taken in September indicated a significant difference in fresh weights of roots between roots grown in 112 cavities and 91, 77 and 60 cavities. These differences were not significant when dry weights were compared. In case of roots obtained from 45, 28 and 20 cavities the differences in fresh and dry weights of roots were found to be non significant at 5 percent level.

Effect of different treatments on the parthenolide content of feverfew (*Tanacetum parthenium*)

Seeds of *Tanacetum parthenium* (feverfew) were obtained from two sources, Johnny's Seeds and Richter Herbs. They were germinated in a commercial soilless growing medium in the middle of January and then transplanted into 10 cm plastic containers in late February. Normal greenhouse cultural practices were followed.

Seedlings from the both seed sources were harvested at an interval of one week and four weeks from seeding and at floral buds initiation. The entire plant was harvested, air dried and parthenolide content was determined by using High Pressure Liquid Chromatography (HPLC) on an acetone extract. Significant differences were found in parthenolide content between these two seed sources. Plants grown from Johnny's Seeds show-

ed a parthenolide content ranging from 0.13 to 0.24 percent (w/w) while in case of plants from Richter Herbs varied between 0.49 to 0.74 percent (w/w). It was also found that in one case where plants were exposed to water spray after harvest, the parthenolide content dropped from 0.245 to 0.19 percent. It was found that parthenolides are present in the trichomes on the leaf surface and water applied to leaves after harvest can damage the trichomes resulting in a loss of parthenolides.

In another experiment feverfew from Richter Herbs was seeded in the middle of August in a soilless growing medium and transplanted into 128 cell packs in early September. In the middle of September the seedlings were planted into 15 cm plastic pots. During the first week of October, when the plants were well established, they were split into blocks to receive three water treatments. There were 3 replicates with 10 plants in each replicate. Control plants received water when the weight of the pot dropped to 80 percent of the saturated weight. In the second treatment plants were watered when the weight dropped to 60 percent of the saturated weight and in the third treatment the plants were watered when wilting of leaves was visible. The plants were harvested towards the end of October, 73 days from seeding. Plants which were grown at 60 percent of the saturated weight showed a fresh weight of 46.2 grams/plant and a dry weight of 4.58 grams. Control plants which were watered at 80 percent of the saturated weight showed a fresh weight of 39.3 grams/plant with a dry weight of 4.11 grams. The plants which received water at wilting point had a fresh weight of 36.4 grams/plant with a dry weight of 3.82 grams. Percentage parthenolide in plants from control groups had a parthenolide content of 0.58 percent (w/w), followed by 0.54 percent in plants receiving water at 60 percent of the saturated weight. The plants which were watered at wilting point had a parthenolide of 0.67 percent (w/w). This indicates that parthenolide contents can be improved in feverfew at a lower moisture content in the growing medium.

Observations on the growth of *Polygonum multiflorum* (Fo-ti)

Fo-ti is a herb from China which is called " Elixir of Life". Observations were carried out on its growth and production of underground tuber like structures, under greenhouse conditions. Cuttings were taken from a stock plant in the first week of April and rooted in a commercial soilless medium. In the first week of May 20 rooted cuttings were planted into 1.3 sq.m. wooden bins containing a soilless medium. A total of three bins were used for planting. A wire frame was constructed to accommodate its climbing habit. Plants were fertilized with a complete nutrient solution with nitrogen at 200 mg/L. Biological controls were used for aphids and thrips. The harvest of underground tuber like structures was completed in the third week of October.

On an average each bin yielded 200 tuber like structures with an average weight of 3.78 grams. These tuber like structures were dark brown, fleshy and appeared like mini-sweet potatoes. Fo-Ti appears to have a potential of becoming a commercial crops for greenhouses.

Evaluation of citric and phosphoric acid to control pH in bedding plants plug production

This project was carried out with the cooperation of High Q greenhouses in Morinville and Wallish Greenhouses in Sherwood Park. The impact of pH regulation of fertilizer solution with citric acid and phosphoric acid was studied in 21 bedding plant species. Data was taken on fresh and dry weights, plug media and tissue nutrients and pH changes in the medium over a period of time. All species were grown at a temperature range from 18 to 22°C and were treated with citric or phosphoric acid applied as a part of nutrient solution during the first two weeks after germination and were grown under natural day light conditions for Edmonton and surrounding areas.

Some of the conclusion from this study are: 1) Pansy, petunia, primula, snapdragon and vinca showed the signs of iron deficiency when pH started to rise over 6.8; 2) Celosia, dianthus and portulaca continuously pulled the pH of media towards acidity; 3) Both pansy and petunia are good indicator of baseline pH readings;

4) Optimum fresh and dry weights for 21 bedding species at the time of planting are different from each other; 5) Phosphorus levels in the plug media and the tissue was higher where phosphoric acid was used for pH adjustments as compared to where citric acid was used.

The detailed data is available in report entitled *Role of Media pH in Plug Management and Citric Acid Evaluation* by M. Younus, W. Chen and M. Mirza, CDCN, November, 1997.

Effect of potassium permenganate in nutrient solution on the growth of seedless cucumbers

This experiment was conducted to find out if manganese supplied from potassium permenganate can be used as a source of nutrient by seedless cucumber seedlings. Cucumber cv Corona was seeded in the middle of November and transplanted into 10 cm rockwool blocks in the third week of November. The treatments consisted of (1),control which was a complete nutrient solution with 0.8 ppm of manganese from manganese chelate, (2), 10 ppm of menganate from potassium permenganate without manganese from manganese chelate and (3) 50 ppm of menganate without manganese from manganese chelate. There were four replicates in each treatment with 10 plants in each replication. The treatments started immediately after transplanting. A flood system was used to irrigate the plants. Plants constantly received the nutrient solutions. Plants were grown under HPS lights with a photo period of 16 hours. Plants were harvested in the middle of December and fresh and dry weights were determined. A chemical analysis of nutrient solutions in all three treatments was conducted.

The following conclusions were drawn from this experiment: 1) Seedless cucumbers were able to utilize manganese from potassium permenganate without any visible symptoms of manganese deficiency or toxicity; 2) Fresh weights on the average from all replicates were 43.16 grams, 44.10 grams and 32.61 grams/plant respectively for control, 10 and 50 ppm of permenganate. Fresh weights obtained from plants receiving 50 ppm of menganate was significantly lower than those obtained from control and 10 ppm, while the differences were non significant between treatments on a dry weight basis.

The nutrient solutions showed a manganese level of 0.82 ppm in control, 3.39 ppm in case of 10 ppm of permenganate and 26 ppm in case of 50 ppm of permenganate. Precipitate noticed in nutrient solutions where permengante was used appeared to be iron oxide but it did not cause any nutrient deficiency or toxicity problems in the seedlings. There was a visible reduction in the amounts of roots coming out of the rockwool blocks which received the highest permenganate treatment.

Evaluation of Japanese tomato cultivars for yield potential under Alberta greenhouse conditions

Japanese tomato cultivars Passion, Tropicboy, Odoriko and Crimson were seeded in the first week of April in 2 cm rockwool cubes and germinated at 22°C. They were transplanted into 10 cm rockwool blocks in the middle of April and planted into the greenhouse in the first week of May. Sawdust was used as a growing medium and the plant density was 2.5 plants/sq.m. Standard cultural practices were followed. Bumble bees were used for pollination. The harvest began in the second week of July and the crop was terminated in the third week of September. The total marketable yields ranged between 12.6 kg to 13.9 kg/sq.m. The yield differences between cultivars was not statistically significant. It was found that these cultivars were very susceptible to blossom end rot and powdery mildew. These two problems resulted into much lower yields when compared to industry standards. A consumer evaluation through a store indicated a high acceptance due to low acidity and slightly pinkish color.

Evaluation of bitter melons as a commercial crop for Alberta greenhouses

The bitter melon *Momordica charantia* is a member of the cucurbit family and is widely used in oriental cooking. The bitterness of the fruit is due to an alkaloid momordicin to which various medicinal properties are attributed. The purpose of this experiment was to evaluate its potential as a greenhouse crop. Cultivars 422M and 422R obtained from Stokes Seed Company and a Chinese cultivar obtained from Tianjin Vegetable Research Centre, China were used in this study.

The seeding was done in the first week of April and planted on sawdust bags in the second week of May at a density of 2.5 plants/sq.m. First harvest was in the second week of July and the crop was terminated on September 25. Bumble bees were used for pollination. Cultivar 422R yielded 4.18 kg/sq.m. followed by 422 M at 3.85 kg and the Chinese cultivar at 2.97 kg. The fruit weight was the highest in the Chinese cultivar at 133.8 grams. Further testing is needed to improve yields by studying the nutrient requirements, better training methods and finding out the optimum number of bumble bees required for pollination.

Observations on the growth of poinsettias grown on different watering regimes

Watering plants by using weight of the growing medium is widely used in tree seedlings. This concept was studied in poinsettias in a commercial greenhouse. Plants of cultivar Freedom which were well established in late September were used. There were three treatments. Control group of plants was watered when the average weight of 10 pots dropped to 80 percent of the saturated weight. In second group plants were watered when the saturated weight dropped to 60 percent of the saturated weight and in the third group plants were watered when the signs of wilting were evident. There were three replicates in each treatment with ten plants in each replication. The watering on weight basis was continued until bracts started showing color in late October. Observations were made on fresh and dry weights, bract development and general plant appearance.

Following observations were recorded: 1) On the average it took 5 days and 8 days for the plants to reach 80 and 60 percent of the saturated weight and 10 days to reach wilting point. 2) The fresh weight was the highest in plants receiving water at 60 percent of the saturated weight and the lowest in plants which were watered at wilting point. 3) Bract size was the smallest in those plants which received water at wilting point. The indications are that poinsettias can be watered on a saturated weight basis. Further work is needed to develop guidelines in this direction.

Observations on needle browning in white spruce seedlings

The problem of needle browning in white spruce seedlings grown under greenhouse conditions appears every year. During 1997 season it was particularly serious in some greenhouses. Brown needles were collected in July from a crop which was seeded in late February and in which the symptoms started to appear in late June.

The needles were analysed for mineral contents and following observations were made. 1) There was a considerable loss of moisture from the browned needles when compared to the healthy one. Moisture determined at 600°C was 70.8 percent in healthy needles and 31.3 percent in browned needles. 2) Among the major nutrients calcium, phosphorus and nitrogen were lower in browned needles and potassium was higher. 3) Both iron and manganese were very high in the browned needles when compared to the healthy one.

The problem was traced to very high moisture deficit (over 7 grams/cubic metre of air) at the time of bud set which caused the plants to loose more water than the roots can absorb. Iron and manganese can accumulate to a toxic levels under such a high moisture deficit. A detailed report is available under the title " Greenhouse Environmental Controls to Produce Good Quality Seedlings" in Module VI Forest Nursery Grower & Seedlings Silviculture Course, October 7-9, 1997, Manual.

Biochemical characterization of active ingredients in *E.angustifolia*

Bob Currie and Yumiko Hoyano, Food Quality Branch

The objective of these experiments to find a suitable method to test medicinally important ingredients of echinacosides present in *Echinacea angustifolia*. Crude methanolic extracts from the roots of *E. angustifolia* were chromatographed on a Sephadex LH2 column to roughly separate the non-polar compounds from the polar compounds. The polar fraction contains the target compounds. Currently the extraction of the root of *E. angustifolia* is carried out by Soxhlet extraction with methanol and the extract is fractionated on a Sephadex column. The fractions from the column are tested by Thin Layer Chromatography (TLC) to see which fraction contains the sugar moiety using specialized reagents. These fractions are chromatographed by High Pressure Liquid Chromatography (HPLC) to provide the profile of the components.

A typical fraction after the above characterization showed three peaks by HPLC and these peaks were fractionated by repeated injection. When enough samples were collected, proton-NMR revealed that one fraction contained protons which can be assigned to three anomeric protons of two glucose and one rhamnose molecule. These three sugars are found in the molecule of Echinacoside.

In order to obtain a large quantity of this compound, a preparative HPLC column was purchased and isolation of the target compound is underway. Once sufficient amounts of material have been isolated and verified, an analytical procedure for the determination of echinacosides in echinacea roots and leaves will be developed.

An examination of the effects of the permenganate ion ($MNO4^-$) on three plant species

Trevor Lantz, Department of Agriculture, Forestry and Nutritional Sciences, University of Alberta & M. Mirza

Potassium permenganate is commonly used as a disinfectant in a variety of contexts. It is a dark purple odorless crystal that is purplish red in solution. It disassociate into the potassium (K^-) and permenganate ions ($MnO4^-$) when dissolved in water. Under most conditions the permenganate ion further disassociate into Manganese dioxide (MnO_2), liberating two, extremely reactive elemental oxygen molecules. Thus, the oxidizing properties of permenganate make it a rapid and energetic disinfectant, potentially useful in horticulture in many ways. The possible phytotoxicity of this chemical and its effect on the growth of geranium, lettuce and cucumbers was investigated.

Following are conclusions drawn from this study: 1) Among the three plant species studied the response to 10,30,50 and 100 ppm of permenganate on growth was variable between species. 2) Cucumbers fresh weights generally decreased in response to increasing treatments and there were significant differences between treatments. However, the differences were not significant between treatments when dry weights were compared. 3) Geraniums generally did not show any significant response to permenganate treatments when fresh weight data was plotted by either treatment or replicate means. Dry weights appeared to increase with the treatments but differences between groups and among groups were not significant. The number of floral buds developed on plants treated with 100 ppm of permenganate were significantly higher than all other treatments levels. 4) When lettuce fresh weights were plotted by replicate it appeared that there was a gradual reduction in biomass accumulation with higher treatment levels.

This was a research project carried out by Trevor Lantz as a part of his AFNS 500 course at the University of Alberta. A detailed report is available under the title " An Examination of the Effects of the permenganate Ion ($MnO4^-$) on Three Plant Species."

Technology Transfer Services

Greenhouse production information was supplied to over 300 people during the year. Over 200 site visits were conducted. One open house in August combined with Special Crops attracted over 150 participants. Three Echinacea Production Workshops were attended by 130 people. Greenhouse Coverings continued to be an important part of technology transfer to growers in Alberta and worldwide. Since this publication was placed on our web site the number of visits increased. The greenhouse specialist attended an International Symposium on Hydroponics in Windsor, Ontario and presented a paper on the production of medicinal plants. The staff presented five talks at the Alberta Horticultural Congress held in Edmonton.

Micropropagation

K. Pruski and T. Lewis

The 1997 was a year of major changes to the micropropagation program. Due to privatization of the tissue culture production the program was reduced to a necessary minimum and is now focussed on germplasm maintenance, tissue culture research and extension.

As of April 1, 1997 the new entomology program was initiated at CDCN. The program will provide the horticultural crops growers in Alberta with extension and applied research in areas of insect control and integrated pest management (IPM). The ultimate goal is to increase the skills and knowledge of horticulture crop producers to recognize pests and to apply proper pest management techniques. The entomology program is still "under construction" and the entomology laboratory is being organized.

Tissue culture plant material available at CDCN:

Species	**Cultivar**
Chokecherry	Garrington, Goertz, Robert, Lee Red, Yellow Boughen
Mongolian Cherry	#2, #4, Beaverlodge selection
Nanking Cherry	Black, White (Lee orchard)
Pincherry	Liss, Jumping Pound, Lee #1, 2, 3, 4
Raspberry	Wyoming (black), Redbrook, Fallbrook
Saskatoon	Altaglow, Beaverlodge, Bluff, Buffalo, Forestburg Honeywood, Lee #2, 3, 5, 8, 10, 11, 12, Martin, Moonlake, Nelson, Northline, Pasture, Parkhill, Pearson II, Pembina, Quaker, Regent, Smoky, Success, Thiessen,
Sour Cherry	Lutowka (Schattenmorelle) and Evans

Research Projects

Several micropropagation research projects were conducted at the laboratory in 1997. Data generated from the project on long-term storage of cultures is now used by the growers in their laboratories. Work on this project was presented at the Society for In Vitro Biology Congress in Washington, DC last summer and the abstract was published in the scientific journal In Vitro. Following are projects conducted at CDCN.

In vitro propagation of Chokecherry, Pincherry, Nanking and Mongolian Cherry (*Prunus virginiana, P. pensylvanica, P. tomentosa* and *P. fruticosa)*

Work on micropropagation of chokecherry cultivars Garrington, Goertz and Robert, pincherry selections Liss and Jumping Pound, black and white Nanking cherry and Mongolian cherry continued. Methods tested (various media, various explants) proved to be suitable for these species. Pre-rooting of microcuttings in vitro (for about two weeks) before transplant to the greenhouse increased the rooting percentage in all species tested. No dormancy was observed with chokecherry cultivars in winter months, December 97/ January 98. This differs from December 96/January 97 where all chokecherry cultures went dormant and gibberellic acid was used to overcome the problem.

Micropropagation of raspberry cultivars Fallbrook and Redbrook

Research work on rapid multiplication and rooting of two raspberry cultivars continued. It was found that the addition of charcoal to the initiation medium was necessary to control secretion of phenolic compounds from raspberry explants to the medium. Once on multiplication medium, cultures of both cultivars grew more vigorously without charcoal. Tidhiazuron (TDZ) was found effective in culture establishment and multiplication.

Potato microtubers in seed potato production in Alberta

After three years of preliminary work on in vitro tuberization of potato the research project on utilization of microtubers in seed potato production is under way. Cultures of three cultivars, Russet Burbank, Atlantic and Shepody were initiated. In vitro tuberization experiments will start in early January 1998. Use of jasmonate in tuberization will be tested. In vitro produced microtubers will be then tested in greenhouse and field production. The project is partially funded by Potato Growers of Alberta.

Evaluation of ORTHENE^{R} against wooly elm aphids and its effect on fruit yield in saskatoons

This is a joint work with Alberta Research Council in Vegreville (Dr. Ken Fry). It includes the use of the insecticide Orthene^{R} as a part of integrated pest management system. The one acre saskatoon test field was planted at CDCN and work on the project begun in June 1997. The project is partially funded by Alberta Professional Horticultural Growers Congress Founda-tion.

The use of GARLIC BARRIER^{R} insect repellent in control of root maggots in cole crops

Preliminary studies were done with the Garlic Barrier repellent. Several commercial vegetable growers were selected and work was done on their fields. The Garlic Barrier was included in the regular insecticide spray schedule which growers use. So far the results were inconclusive and the proper statistical design of testing is needed to achieve reliable results. The manufacturer provided the product and some small equipment to conduct the study.

Technology Transfer Services

Micropropagation. The focus was on education and technology transfer to growers (who have tissue culture laboratories) in all aspects of micropropagation, tissue culture production and disease-freeing procedures. An advanced tissue culture course was organized by the staff. Consultations, diagnostics, problem solving to growers was maintained via phone calls and office visits. The tissue culture technologist participated in a Congress on In Vitro Biology in Washington, DC and presented the scientific paper "Sucrose and Low Light Effects on In Vitro cultures During Cold Storage". Information on recent advancements in tissue culture technology and production were brought back and transferred to growers through on-site visits and reports. Received funds to conduct the project on in vitro tuberization of potato from Potato Growers of Alberta and Alberta Research Institute. Data generated during the course of the study will be published in the annual report.

Entomology. The focus was on organization of the program. During the initiation of the program the program leader was able to visit many greenhouse, field vegetable and fruit growers across Alberta. Many aspects of insect management and controlwas discussed. The integrated pest management (IPM) concept was the main topic of discussion among all three commodity groups. Extension work was carried out through commodity newsletters (greenhouses, fruits), phone calls and on-site visits. Received funds from Alberta Market Gardeners Association for the project on "Integrated Pest Management Approach in Control of Root Maggots in Cabbage Crops in Alberta." Jointly with Dr. Ken Fry (ARC, Vegreville) received funds from Alberta Professional Horticultural Growers Congress Foundation for the project "Evaluation of the Orthene^{R} against woolly elm aphids and its effect on fruit yield in saskatoons."

Nursery Crops Program

C.L. Murray, N.G. Seymour (CDCS) and T.T. Pheh (CDCN)

The nursery crops program is focused on research into cultural management practices for nursery crops and the evaluation of new woody plant cultivars. Extension activities are directed to growers and other members of the nursery/landscape trades and also includes a close association with Landscape Alberta Nursery Trades Association (LANTA).

The nursery crops program at CDCS in Brooks and CDCN in Edmonton is managed by C.L Murray from Brooks as a single group located at two sites. This change occurred upon the retirement of B. Casement from CDCN at the end of March 1997. The nursery crops program at CDCN in coordinated by technologist T. T. Pheh and at CDCS by N.G. Seymour.

Woody Plant Evaluation Trials

Prairie regional trials (CDCS and CDCN)

The Prairie Regional Trials (PRT) were established in 1958 to test the hardiness of woody plants on the Canadian Prairies. Dr. C. Davidson at the Agriculture and Agri-Food Canada Station in Morden, Manitoba coordinates the trials and provides the plant material for the eight prairie sites.

Plant material is evaluated in the trials at CDCS and CDCN for five years. Each year height and width are measured and the plants are visually rated for quality . The data collected are sent to Morden where they are summarized and a report is produced approximately every three years.

The 1997 additions to the trial to both sites were:
Aronia mandshurica

Betula lenta - Black or Cherry birch
Rosa #84SOJ401
Rosa #N3
Rosa #N6
Rosa 'Alexander MacKenzie' - Alexander MacKenzie rose
Rosa 'Morden Amorette' - Morden Amorette rose
Rosa 'William Baffin' - William Baffin rose
Rosa 'Winnipeg Parks' - Winnipeg Parks rose

CDCS only:
Rosa #Y2
Betula albo-sinensis - Chinese Paper birch
Physocarpus opulifolius 'Darts Gold' - Darts Gold ninebark

CDCN only:
Lonicera ruprechtiana - Naked Manchurian honeysuckle
Rosa 'John Davis' - John Davis rose

Regional woody plant test program

Since 1983, CDCN and South, the LANTA Growers Group and Research Committee have cooperated on the Regional Woody Plant Test Program (RWPTP). New tree and shrub introductions to Alberta are grown for five years at seven different sites representing different climatic regions in the province. Growth data is collected and plant material is visually rated yearly. Selected graduates of the RWPTP are featured in a garden centre plant promotion program called Garden Select.

Additions to the RWPTP at the seven test sites including CDCN and CDCS in 1997 were:
Celtis occidentalis - hackberry, Eagle Lake Nursery selection
Cornus alba 'Bud's Yellow' - Bud's Yellow dogwood
**Fraxinus nigra* 'Brendan's selection' - black ash
**Fraxinus pennsylvanica* 'Brendan's selection' - green ash
Fraxinus pennsylvanica 'Prairie Spire' - Prairie Spire green ash
Fraxinus pennsylvanica 'Prairie Dome' - Prairie Dome green ash
Lonicera x brownii 'Dropmore Yellow' - Dropmore Yellow honeysuckle
Salix repens - Creeping willow
Spiraea arguta 'Compacta' - Dwarf Garland spiraea
Spiraea japonica alpinum 'Daphne' - Daphne spiraea

*These selections were made from trees which were sent as seedlings to the city of Edmonton from the tree breeding program at Agriculture Canada at Morden, Manitoba by Dr. W. Ronald. Selections were made by B. Casement and R. Nyroos (former city of Edmonton forester).

For more information about the RWPTP from 1983 to 1996 see Regional Woody Plant Test Project, Summary Report - 1996, CDCN Publication #96-S10.

The University of British Columbia plant introduction program - CDCS

The University of British Columbia Botanic Garden Plant Introduction Program selects superior plant material from many sources to test for suitability for introduction into the nursery-landscape industry.

There were five new selections from this program planted in 1997 at CDCS:
Philadelphus (P. delavayii, P. melanocalyx x P. lewisii) - Mockorange
Arctostaphylos uva-ursi (clone A) - kinnikinnik, bearberry
Arctostaphylos uva-ursi (clone B) - kinnikinnik, bearberry
Artemisia frigida
Rosa woodsii 'Kimberly' - Kimberly wild rose

All-America selections - CDCS

All-America Selections is a non-profit organization dedicated to promoting the development and introduction of improved cultivars of flowers and vegetables. CDCS is one of the approximately 35 trial sites in North America. The results of the evaluations from all the sites are tabulated and the best selections are released 18 months later. In 1997, 15 flower selections were evaluated.

The best selections from the All-America Selections to be available in spring 1998 are: Impatiens 'Victoria Rose' and Petunia 'Prism Sunshine'.

Bur Oak Provenance trial - CDCN

The Bur Oak Provenance Trial is a cooperative trial with the Great Plains Agricultural Council, Forestry Committee and coordinated in Canada by W.R. Schroeder, PFRA Shelterbelt Centre in Indian Head, Saskatchewan. The objectives of the project are: 1) to determine the nature and extent of bur oak genetic variation; 2) to provide genetically improved bur oak seed for shelterbelt planting; 3) to provide germplasm that can be used for selection and trial improvement as well as advanced-generation breeding; 4) and to survey *Curculio* spp., acorn weevil, distribution and its impact on seed quality.

The project began in 1993 and is expected to run for approximately 20 years. There are 48 accessions in the trial from the following locations: Manitoba (19), Saskatchewan (4) , Minnesota (4), Montana (3), North Dakota (16), South Dakota (2).

Vineland Apple Rootstock Trial - CDCN

The Vineland Apple Rootstock Trial is a cooperative trial coordinated by J. Cline, Horticultural Experiment Station, Simcoe, Ontario. The trial will evaluate the cold hardiness of the "V" series of rootstocks. There are currently four standard selections to act as a control and five new selections bred at the Simcoe Station. The trees were planted in 1997 and will be on trial for five years.

Research Projects

Investigation of controlled-release fertilizer for container-grown woody plants in Alberta. C.L. Murray and R.C. McKenzie

Effective, efficient fertilizer management is necessary for container growing of woody plants to be economically viable in Alberta. Controlled-release fertilizers have been used extensively in other nursery growing regions of North America, however, research conducted in other locations does not apply because of the different climatic conditions in Alberta.

A two year trial was undertaken using four shrub species: *Juniperus sabina* (Savin juniper), *Ribes alpinum* (Alpine currant), *Syringa meyeri* (Dwarf Korean lilac) and *Potentilla fruticosa* 'Coronation Triumph'(Coronation Triumph potentilla) grown in soilless media in 7.6L containers. Four types of fertilizer were applied: 8-9 month + 3-4 month Osmocote at 0+100 percent, 40+60 percent, 60+40 percent and 100+0 percent and three nitrogen (N) rates were applied: 4.8, 6.4 and 8.0 g N/ pot for a total of 12 treatment combinations. For the control treatment, water soluble fertilizer (200 ppm N) was applied at each irrigation.

In late September 1996 growth for all species were greater when the fertilizer type contained 40 to 100 percent of 3-4 month controlled-release fertilizer. For currant, juniper and lilac growth was greatest at 8.0 N

rate while N rate did not affect the growth of the potentilla. In late September 1997, currant growth was greater in fertilizer type treatments containing 40 to 100 percent of 3-4 month fertilizer while there were no significant differences among the treatments for potentilla and juniper.

About 80 percent of the lilacs were winter killed over the 1996-97 winter so no growth data was collected in 1997.

Acknowledgements: The authors wish to thank the groups involved in the cooperative funding of this project: Alberta Agriculture Research Institute, Eagle Lake Nurseries, Scott's Company and the Landscape Alberta Nursery Trades Association Growers Group.

Investigation of the growth of two species of field-grown trees at different nitrogen fertilizer rates. C.L. Murray and R.C. McKenzie

Field-grown plant material is the largest segment of the nursery industry in Alberta. Alberta growers reported $11.2 million in sales of deciduous and coniferous trees and shrubs in 1992 (Pacific Resource Consultants, 1993).

There is inadequate information about the management of tree fertility for maximum tree growth while avoiding over fertilization which may result in winter kill or dieback of trees in the short Alberta growing season.

Picea pugens 'glauca' (Colorado blue spruce) seedlings and *Fraxinus pennsylvanica* (green ash) were planted on an unirrigated site at Edmonton and an irrigated site near Brooks. Four replications of groups of two or three trees of each species received N fertilizer to reach each one of four soil N levels: control (no added fertilizer), 50, 90 and 130 kg N/Ha. In Brooks the trees were planted June 11, and fertilizer was applied June 23, while in Edmonton the trees were planted in early May (spruce, May 1996) and fertilizer was applied as a split application in mid June and the first week of July.

Trunk caliper at 15 cm above the soil level or above the graft union and tree height were measured at transplanting and again in October. Data will continue to be collected for the experiment for a minimum of three more growing seasons.

There were no significant differences in tree caliper increase (increase from May to late September 1997) as a result of the N treatments. A significant increase in growth due to the application of the N treatments cannot be expected in the first season as the trees are recovering from transplant shock. Results from the first season after transplanting into the field may also be affected as the trees are still be benefitting from N stored in the tissues from the previous growing season.

Acknowledgements: The authors wish to thank the following organizations for the financial support of this project: Alberta Agriculture Research Institute, Arrowhead Nurseries, Edmonton and the Alberta Ornamental Plant Foundation.

Evaluation of Prairie Mix controlled-release fertilizer for growing woody plants in Alberta

Preliminary results from, *Investigation of controlled-release fertilizer for container-grown woody plants in Alberta*, conducted at CDCS, indicated that the growth of potentilla, alpine currant and lilac was greater when grown with fertilizers with 40 to 100 percent 3-4 month release period Osmocote controlled-release fertilizer. Based on these preliminary results, Prairie Mix fertilizer, a custom-blended, controlled-release fertilizer, was created for use under Alberta climatic conditions. The 21-3-7 was manufactured for a 5-6 month release period and is a combination of controlled-release 19-6-12 and Poly-S (a coated urea product).

Rooted cuttings of *Ribes alpinum* (Alpine currant), *Cornus alba* (Tatarian dogwood), and *Potentilla fruticosa* 'Coronation Triumph' (Coronation Triumph potentilla) were planted into 7.6 L containers filled with a soilless media. Plants of each species were fertilized with Prairie Mix fertilizer at 4.8, 6.4 or 8.0 g N/pot or 8.0 g N/pot of 40+60 percent of 8-9+3-4 month

Osmocote controlled-release fertilizer for the control.

There were no significant differences for growth index among fertilizer N rates or between the control and the other treatments for any of the species evaluated. These results indicate that there was little benefit to the application of higher N rates; however, this contradicts the results of the first year of the controlled-release fertilizer study which indicated that plant growth for currant and potentilla was greater at the highest N rate. To complete the study the plants are being overwintered and growth will be evaluated for a second season in 1998.

A comparison of the growth of native plants grown in containers at three nitrogen rates and in the field

Native plants can be valuable in the landscape, for site reclamation or for shelterbelts. They are often slow growing; however, if growth could be accelerated with improved crop management, native plants would be a more profitable crop.

Rooted cuttings of *Sheperdia canadensis* (buffaloberry), *Rosa woodsii* (wild rose) and *Larix laricina* (larch) were transplanted into soilless media in 3.8L containers. Container-grown plants were fertilized at each of three levels of N (3.1, 4.8, or 6.5 g N/pot) and the field-grown control was fertilized at the high N rate. Height and width of each plant was measured in September 1997 and plants are being overwintered and will be grown for a second season in 1998.

In the first season the growth was greatest for larch at the high N rate, while the buffaloberry growth index was greater at the medium rate than the lowest N rate. There were no differences among N rates for rose growth. The highest rate of N did not result in greater growth for the buffalowberry or rose likely because these species are relatively slow growing; thus, they were unable to utilize the available N. Growth was greater for all species when container-grown compared to field-grown indicated that the high level of management of fertility, media and irrigation was beneficial to the three species.

Evaluation of the effect of media, IBA concentration and timing on rooting efficiency for softwood cuttings of six species of woody plants

A number of species of shrubs are considered by growers to be difficult-to-root using softwood cuttings and this limits their availability in the marketplace and increases the cost of production of these species. Many factors including the properties of the media, concentration of rooting hormone applied and the time when the cuttings are taken are known to effect the success of rooting.

Cuttings of new green shoots 7 to 10 cm long were collected from mature *Sheperdia argentea* (Silver buffaloberry), *Syringa x hyacinthiflora* 'Royal Purple' (Royal Purple lilac), *Prunus pennsylvanica* (pincherry), *Corylus cornuta* (Beaked hazelnut), *Prunus triloba* 'Multiplex' (Double Flowering plum) and *Amelanchier alnifolia* (saskatoon). Cuttings were collected on 23 June, 10 July and 22 July 1997 and were stuck the same day into styroblock cell containers. The following treatments were applied to the cuttings of each species at the three dates: two media 50:50 (peat:perlite), 30:30:40 (sawdust:perlite:peat) and two IBA (indole-3-butyric acid) powder concentrations (0.4 percent, 0.8 percent). Cuttings were evaluated for root development after five weeks.

Rooting for all species was very poor except Double Flowering plum which rooted from 55 to 85 percent. Poor rooting may have been the result of the timing of the cuttings or because initially the greenhouse environment was too warm with insufficient humidity for rooting success. There were significant differences in rooting due to cutting date, medium type and IBA concentration, but all treatments resulted in very poor rooting.

This study will continue in subsequent seasons to evaluate various treatments to improve rooting of difficult-to-root woody plants.

Plant Collections CDCS

The **Golden Prairie Arboretum** was established in 1981. The collection now contains 312 species of 68 genera for a total of 531 deciduous trees and shrubs. These plants represent most of the deciduous woody plant species that can be grown on the prairies. A complete listing of the collection is available in Golden Prairie Arboretum ASCHRC pamphlet 93-1.

The **Forever Green Pinetum** collection of coniferous trees and shrubs was established in 1986. At present it contains 26 species of nine genera for a total of 120 trees and shrubs. A complete listing of the collection is available in Forever Green Pinetum ASCHRC pamphlet 93-12.

The **Rose Garden** contains 241 specimens, many of which are unique to the Brooks collection. Many early Canadian rose cultivars and notable crosses of Canadian rose breeders, Skinner, Bugnet and Wallace are maintained in the collection.

Plant Collections CDCN

The McAlla Arboretum at CDCN currently being redesigned to reduce maintenance. To date 192 taxa have been planted in the redesigned Arboretum.

Technology Transfer Services

Technology transfer to the growers is accomplished through nursery visits as well as by the production and distribution of the Nursery Crops Trial Report and presentation of seminars. In 1997 two seminars were presented at the Alberta Horticulture Congress: Woody plant fertility research in Alberta and Surfing the web for Internet sites of interest to nursery growers.

Participation in the LANTA Research Committee, Growers Group and the Western Nursery Growers Group allows for excellent communication with industry members.

As well in 1997, the program leader attended the International Plant Propagators Society Annual Conference in Richmond, BC and the Western Nursery Growers Group Tour of the Portland, Oregon area. The conference and tour were both excellent opportunities to observe the innovations and trends in the large competitive growing regions of Oregon and the Fraser Valley of BC.

Plant Pathology Program

P. Bains, H. Bennypaul, P. Taschuk, R.J. Unguran and M. Yu

The objective of the program is to maximize profits of Alberta growers by reducing crop losses caused by disease. The objective is achieved through research and technology transfer. Research projects were funded by Potato Growers of Alberta, Fruit Growers Society of Alberta, Alberta Agricultural Research Institute, Agricultural Development Fund (Saskatchewan Agriculture), and Novartis Crop Protection.

Research Projects

Rhizoctonia Disease of Potato (*Rhizoctonia solani*)

Rhizoctonia stem canker and black scurf (*Rhizoctonia solani*) is a serious disease of potato in temperate regions of the world and causes significant economic losses to Alberta potato growers. Field experiments were conducted at Bon Accord to: 1) identify fungicides which will effectively control the disease, 2) determine the relative susceptibilities of advanced breeding lines and potato cultivars grown in Alberta, and 3) determine the effect of whole vs. Cut seed and cool vs. warm seed on Rhizoctonia disease development. Mr. C.A. Schaupmeyer is a cooperator on the project. Thanks to grower cooperators.

Fungicidal control of Rhizoctonia disease

Naturally infected Yukon Gold seed tubers were treated before planting with Captan 50 percent WP (captan), Maxim 0.33% D (fludioxonil), Maxim 0.50% D (fludioxonil), Mertect 45% F (thiabendazole), Rovral 50% WP (iprodione), and Tuberseal 16% D (mancozeb). Rhizoctonia stem canker severity was determined by recording the length and percentage of stem circumference affected (circumference factor, <25%=1, 25-50%=2, 51-75%=3, >75%=4) for each lesion. Sum of the products of length and circumference factor for lesions of a stem were divided by the product of total stem length and maximum circumference factor. Canker severity was expressed as a percentage of the maximum possible. Fifty days after planting both concentrations of Maxim, Captan, and Rovral reduced Rhizoctonia stem canker severity compared to that of control. At harvest, however all the fungicides, except Easout were effective in reducing the stem canker severity and percent stem infection. Captan and both concentrations of Maxim reduced the percentage of incidence of black scurf on the tubers, however, the severity of black scurf on the tubers was only reduced by Maxim 0.5 percent. The results of various observations taken together suggest that Maxim 0.5 percent was most effective in controlling the disease.

Relative susceptibility of potato cultivars to *R. solani*

Seed tubers of advanced breeding lines (AV 82101-12, F119649-6, V0024-6, V0123-25, V0299-4) and potato cultivars (AC Ptarmigan, Alpha, Amisk, Bintje, Chipeta, Norgold Russet, Norland, Rode Earstling, Russet Burbank, Shepody, White Rose) were inoculated with *R. solani* by placing the inoculum (a mixture of grounded *R. solani* sclerotia and talc) on seed tubers immediately before they are covered with soil. None of the cultivars or breeding lines tested were resistant to *R. solani*. The cultivars showed a continuous range of reactions to the pathogen. AC Ptarmigan, Russet Burbank, and AV82101-12 were more suscep-tible than Bintje, Shepody, V0299-4, and Amisk.

Effect of whole vs. cut and temperature of seed tuber on disease development

The experiment was conducted by planting naturally infected Yukon Gold seed tubers. Before planting the seed tubers were handled to provide the following treatments; cool (directly from storage, 3°C) and cut (whole tuber cut in two), cool and whole, warm (5 days at room temperature) and cut, and warm and whole. Warm and whole seed tubers produced significantly taller plants than that from cold and whole tubers. Similar difference, however was not observed between plants from cold and cut, and warm and cut seed tuber pieces. Later in the growing season, however no visible difference was observed. No difference in heights in plants from cold and cut, and warm and cut seed tubers was observed.

Entomosporium leaf and berry spot of saskatoon *(Entomosporium mespili)*

Fungicide screening trials

Field trials were conducted in 1997 in three commercial orchards of saskatoon. The experiments were conducted to reduce the number of applications of Topas 250E (propiconazol 250g/L), and to evaluate the efficacy of Bravo 500 at 970 g ai/ha. Previously, Bravo 500 at 1535 g ai/ha caused higher than the acceptable limit of fungicide residue in saskatoon berries. Three applications of Topas at 125 g ai/ha reduced the disease severity and incidence on berries and leaves. Two applications of the fungicide, however were not consistently effective. Two of three sites, Bravo 500 at 970 g ai/ha reduced disease severity both on leaves and berries. Saskatoon berry samples have been collected for residue analysis. There was no phytotoxic effect of fungicides on fruit or leaves of saskatoon at any test site.

Development of Benlate resistance in isolates of *Entomosporium mespili*

Isolates of *E. mespili* collected from experimental plots for fungicide screening were tested *in vitro* for their resistance to Benlate 50WP (benomyl). The effect was observed by monitoring radial growth of *E. mespili* isolates on sucrose-casein medium amended with 0.0, 0.05, 0.5, 5.0, and 50.0 ppm Benlate. A concentration of 0.5 ppm completely inhibited growth of some isolates, whereas others grew at 50.0 ppm (the highest concentration tested). Later the isolates were tested by growing them on sucrose-casein medium amended with 0.0 and 50.0 ppm. The results indicated that isolates of *E. mespili* has developed resistance to Benlate.

Effect of temperature on colony growth and spore germination

The effect of temperature on colony growth and spore germination was monitored by growing *E. mespili* from mycelial plugs and by germinating spores, respectively, on sucrose-casein medium in petrie plates at 10, 20, 30, and 40°C. Both colony growth and spore germination were optimal at 20°C.

Field susceptibility of cultivars of saskatoon to *E. mespili*

Comparative susceptibility of ten saskatoon cultivars (Forestburg, Honeywood, Northline, Pearson, Pembina, Parkhill, Regent, Smoky, Success, Thiessen) to natural infection by *E. mespili* was determined in four commercial saskatoon orchards in north-central Alberta. During the growing season a number of observations were

made on the disease incidence and severity both on leaves and berries. Not all the orchards had the same cultivars, each cultivar, however was present in at least two orchards. The cultivars showed a range of reaction to *E. mespili*. Overall, Parkhill, Success, and Thiessen were comparatively less susceptible than the other cultivars.

Late Blight and Other Diseases of Potatoes

A survey of Alberta potato storages for late blight (*Phytophthora infestans*) was conducted in February 1997. Potato piles were visually observed for the disease and any tubers showing suspect symptoms were collected for further observations. Tubers were washed and observed for late blight and other diseases. Microscopic examination to confirm the presence or absence of late blight infection was conducted on suspect tubers. None of the tubers tested showed late blight infection.

Dry rot (*Fusarium* sp.) was present on tubers from all storages. It was noted that high percentage of dry rot infection was associated with physical damage to the tubers. The other two disease which showed high disease incidence included silver scurf (*Helminthosporium solani*) and black scurf (*Rhizoctonia solani*). Three storages showed high percentage of common scab (*Streptomyces scabies*). Pythium leak (*Pythium* sp.) and soft rot (*Erwinia* sp.) were also observed.

In 1997, a total of 45 potato fields were surveyed for Late blight. In southern Alberta, fields planted with imported seed were specifically surveyed for the disease. The fields were checked visually for late blight symptoms and the suspect samples were examined microscopically. No late blight infection was detected in any of the fields surveyed. Other diseases observed in the fields included blackleg, rhizoctonia canker, and early blight to varying degrees of severities. Late in the season some fields developed severe early blight.

Powdery Mildew of Tomato

Identification of the cause of powdery mildew of tomato in Alberta

The causal organism of the disease had the following characteristics. Unbranched conidiophores with an unswollen base cell. Elliptical to oval shape conidia with average length and width of 36.0 µm (19.0 to 56.0 µm) and 17.6 µm (12.0 to 25.0 µm), respectively, conidia borne singly or in short chains. Presence of many small vacuoles and absence of fibrosin bodies in conidia. The characteristics fit the description of an *Erysiphae* sp.

Effect of temperature and humidity on germination of conidia of *Erysiphae* sp.

The effect of temperature on germination of conidia was studied by incubating conidia from young colonies on water agar at 15, 20, 25, 30, or 35°C. The percentage of germination was determined after 15, 24, and 40 hours of incubation. Germination of conidia was highest (84 percent) at 25°C. Effect of relative humidity on germination of conidia was determined by incubating conidia from young colonies on glass slides kept at 25°C and a relative humidity of 60, 75, or 90 percent. The percentage of germination increased with increased relative humidity, it was maximum at 90 percent.

Fungicidal control

Ten fungicides including Bayleton (triadimefon), Benlate (benomyl), Bravo (chlorothalonil), Easout (thiophanate-methyl), Funginex (triforine), Karathane (dinocarp), Kumulus (sulphur), Manzate (mancozeb), Nova (myclobutanil), and Rubigan (fenarimol) were evaluated for their ability to control the disease. The fungicide trial was conducted in a greenhouse with nine replications of one plant each. The plants (*Lycopersicon esculentum* Mill. (Tomato) cv. Trust) sprayed with one of the fungicides or water were inoculated by placing infected tomato plants amongst them. Incidence and severity of the disease were observed 7, 14, and 21 days after inoculation. Bayleton, Funginex, Nova, and Rubigan effectively controlled the disease. Due to low disease development, the repeat experiment was suspended. The experiment will be repeated.

Technology Transfer Services

Technical transfer services were provided to growers and industry personnel of various commodities through direct contact, newsletters and written handouts, and presentations at meetings and workshops. Presentations were made at number of area meetings of Potato Growers of Alberta, Western Canadian Saskatoon Pest management Working Group, Alberta Horticultural Congress, Berry School (Fruit Growers Society of Alberta), Echinacea Production Workshop, Canadian Late Blight and Storage Rot, Plant Pathology Society of Alberta, and American Phytopathological Society.

Potato Program

C. Schaupmeyer and C. Feth

The objectives of the Potato Program are 1) to assist in the selection and development of improved potato cultivars and, 2) to establish methods for improving quality and maximizing economic yields in Alberta's potato industry. These objectives are accomplished through research, extension, and service.

Research Projects

Potato cultivar improvement

The Crop Diversification Centre South (CDCS) is one of five cooperative tests sites in the Prairie Potato Breeding Program. The program is managed by the Agriculture and Agri-Food Canada (AAFC) potato breeder, Dr. Dermot Lynch, who makes crosses at the Lethbridge Research Centre and makes preliminary selections at the Vauxhall substation. Final testing is done at the regional sites. Performance of test lines in the regional trials is evaluated by the breeder, test site cooperators, and industry staff.

The primary objective of the breeding program is to select improved potato varieties adapted to the southern Prairies. Varieties needed by the industry include: a chipping variety that is more disease resistant than Norchip and is more stable in long-term storage; a chipping variety that will yield well and chip by the third week in July; an attractive fresh-market red potato that holds colour in long-term storage; a maincrop fresh-market and French fry netted potato that is earlier than Russet Burbank and has better quality.

CDCS participates in cultivar evaluation in several ways. First, as a cooperator in the Prairie Regional Potato Trials, four cultivar evaluation trials containing about 400 lines are planted and maintained. Second, some of the seed for the five regional trial sites in the Prairies is produced. Third, there is participation with industry in the evaluation of advanced cultivars that have graduated from the regional trials. In 1995, co-operative trials began with AAFC to study production-management techniques for graduate cultivars to establish basic agronomic recommendations.

Prairie potato regional trials

Approximately 400 lines were grown in five Regional Trials at Brooks. Data were collected on 30 to 40 agronomic and quality factors including yield, maturity, specific gravity, culinary and processing quality. Data from these trials were sent to Dr. Dermot Lynch at AAFC, Lethbridge for analysis and summarization for the Prairie Potato Breeding and Selection Committee. Data from the regional trials are published in the annual report: *Progress Report, Prairie Potato Regional Trials*, available from AAFC.

Alberta potato industry cultivar evaluation

Potato Industry Cultivar Trials are continuing to evolve. The trials were originally established to evaluate (on a commercial scale) new potato cultivars that have graduated from the Prairie Potato Regional Trials. The trials enabled growers and processors to gain first-hand experience with new cultivars in the field and processing plant. Five years ago the Prairie Potato Breeding Consortium was established and responsibilities for industry evaluation are evolving. The consortium is a corporation funded by membership fees paid by five groups (processors, grower-owned companies, and grower organizations) from the three prairie provinces. Fees are used to pay for research studies directly related to consortium varieties.

Breeding lines entering the registration trials in the Prairie Potato Breeding Program are available for tendering to consortium members. The first tendering process started in late 1995. Successful bidders were assigned either exclusive rights or non-exclusive rights and were authorized to control the production of seed. They are required to pay a "royalty" to the consortium for the right of ownership. The owners of consortium varieties are responsible for market development of the varieties thus reducing the role of CDCS in this process.

In 1997, CDCS increased seed of 17 consortium varieties for trials in 1998.

Potato cultural research

Two production research studies were conducted in 1997. As one was a private contract the study and data are not described.

Effects of In-Row Spacing on the Yield and Quality of Nineteen Potato Lines

This ongoing project is in cooperation with Dr. Dermot Lynch from AAFC at Lethbridge. Graduates of the Prairie Regional Trials that have been designated to the Prairie Potato Breeding Consortium were planted at three in-row spacings to assess the effects of population on yield, tuber size distribution, and quality. Data from the 1997 study were not analysed at this time. There were two trials in this study: an early harvest and a maincrop study. The final report of this 3-year study will be available in 1998 from Dr. D. Lynch.

Technology Transfer Services

The Potato Specialist provides extension service to growers and industry personnel through direct contact, newsletters and factsheets, and presentations at conferences and workshops. In 1993 the Potato Specialist started a series of new extension meetings with growers in Southern Alberta. These were continued again in 1997 in cooperation with the Potato Growers of Alberta. Nine meetings were held in both Taber and Nisku from April through November. Growers, industry staff, and research and extension staff attend these meetings and discuss production management. Attendance at each meeting during the past year was about 50

and 60 growers and industry staff in Taber, and approximately 30 to 40 growers and industry staff in the Edmonton area.

In late 1996 an extension and research needs survey was conducted with members of the Potato Growers of Alberta. Partly as a result of this needs survey two, one-day topic-specific workshops were held in Taber in February and March with 65 and 55 growers and industry staff attending. One workshop was about potato fertility and the second was about weed control and fall bedding. A tissue-culture workshop was held in the Edmonton area in March and a fertility, weed control, and fall bedding workshop was held in Central Alberta in April.

In total approximately 600 growers and industry staff attended informal breakfast meetings and workshops in 1997.

Seed Potato Program

P. Duplessis and T. Lewis

The main objective of the seed potato program at CDCN is to provide support to seed potato growers throughout Alberta. This is accomplished through research trials and extension services. The program works closely with the Alberta Seed Potato Growers Association to ensure that the needs of the industry are being met.

Seed Potato Repository. The purpose of Alberta Agriculture, Food and Rural Development's seed potato repository is to maintain a collection of disease-free plants to ensure that the Alberta seed potato industry has stock material for nuclear production. This is accomplished by multiplying disease tested stock plants for private labs. In 1997, 88 public potato cultivars and accessions and 12 private cultivars were distributed to private laboratories across the Western Provinces for multiplication. In June 1997, Svalof Weibul cultivars were removed from the repository due to Svalof Weibul's decision to maintain plantlets elsewhere.

Nuclear Seed Potato Production and Distribution 1997 marked the first year that the seed potato program did not supplement the industry's nuclear tuber production. Nuclear tubers produced on site are for research purposes only and are not offered for sale.

Research Projects

Enhancement of nuclear seed tuber production from plantlets

In 1997, the second year of a three-year project designed to determine the optimum plantlet spacing for maximization of mini-tuber production in early, mid-season and late maturing cultivars was completed. A second objective of this study was to identify the most effective growth regulators for maximizing the number of viable mini-tubers produced by each individual plantlet. Preliminary results indicate that plantlet spacing has an effect on mini-tuber size and numbers and that certain growth regulators appear to enhance plantlet productivity although additional research is required to evaluate their overall effectiveness. Preliminary results of the field component of this study still have to be analysed to determine the effects of tuber size and growth regulator application on yield. Final results will be presented following the completion of the trial in fall 1998.

Variety demonstration trial

Nuclear tubers produced at this facility are planted in the field on an annual basis for assessment of 'trueness to type'. Evaluation of potato cultivars is necessary to ensure that the seed potato program is providing the Seed Potato industry with a high quality seed source. This past year, the plot included 57 cultivars. Several different lines of the cultivars Russet Burbank, Ranger Russet, Shepody, Russet Norkotah and Norland were included to determine if one line or clone was superior or inferior to the others. It was determined that line 1 of Russet Burbank would not be released until further studies could be conducted to determine if its lack of vigour in 1997 was a result of the growing season or if it truly is inferior to the other lines. Growers visited the plot during the Regional Trial tour and took the opportunity to look at the many cultivars in the repository. Growers showed strong interest in the several red cultivars included in the plot — especially the Norland clones. Growers felt that the Super Red Norland was inferior to the other Norland clones due to its uneven skin colour.

In 1997 the M.D. of Clearhills was supplied with 10 different potato varieties that were included in their alternative crop demonstration trial. At their field day program staff were able to discuss the merits of the different varieties with the area farmers and speak to those interested in seed potato production.

Prairie regional trials—early and main crop replicated trial

These trials are conducted annually in cooperation with the Lethbridge Research Station. They are an integral part of the AAFC Potato Breeding Program. New cultivars and accessions are compared with well known standards to assess performance, maturity, yield, specific gravity, and culinary and processing quality. The observations are used to select new potato cultivars for the prairies.

CDCN was an early and a main crop trial site in 1997 and was also an irrigated and dry-land demonstration trial site for nine advanced selections and eight industry standards. The early crop trial included 16 breeding lines with Atlantic, Carlton and Superior as standards. The main crop trial included 17 breeding selections plus Rode Eersteling, True Blue and Golden Boy for evaluation. Norland, Norchip, Russet Burbank, Shepody, Atlantic and Snowden served as standards. Growers had the opportunity to tour the site on August 20th and Dr. Dermot Lynch of Agriculture Agri-Food Canada (AAFC), Lethbridge, was on hand to answer questions about the advanced selections.

Technology Transfer Services

Co-organized seminars/workshops:

- Tissue Culture Course - for training growers in tissue culture and greenhouse production of woody plants and potatoes.
- Workshop on "Tissue Culture Production and Greenhouse Management for Nuclear Tuber Production", with Dr. Jane Seabrook of AAFC, Fredericton at the Nisku Inn, Nisku, Alberta.
- CDCN Field Day and Grower Tour

Participated in meetings and conferences:

- Prairie Potato Council Annual Meeting, Red Deer, Alberta.
- Washington Potato Conference and Trade Fair, Moses Lake, Washington.
- Attended the 1997 Annual Meeting of the Potato Association of America, Charlottetown, PEI.
- Attended MD of Clearhills Grower Field Day.
- Area meetings of the Potato Growers - organized by the PGA.
- PGA annual meeting, Red Deer, Alberta.

The seed potato specialist provides extensions services to growers and industry personnel through direct contact and presentation at meetings and conferences.

Extension efforts in 1997 focussed on improving nuclear tuber production through grower visits. The visit of Dr. Jane Seabrook in March stimulated many of the growers to improve their production systems and program staff attempted to help them solve any problems that arose throughout the growing season. As growers become more familiar with the new staff in the seed potato program it is hoped that even stronger ties within the industry will develop

Vegetable Crops Program (Edmonton)

B. Choban and C. McIsaac

The vegetable crops program at CDCN works jointly with the vegetable crops program at CDCS to provide the vegetable growers in Alberta with technology transfer and field research that responds to growers needs, current market demands and industry's growth. Field research at Edmonton focuses on the needs of market gardeners and wholesale producers in north and central Alberta.

Research Projects

Research was directed at cultivar evaluations, crop diversification, improving post harvest handling and production management. Research consisted of applied field trials on crops of greatest economical importance to the industry. It was guided by industry demand and was coordinated with research work being done at CDCS.

Kuhlmann's Market Gardens provided substantial financial assistance to support the research trials through the Alberta Agricultural Research Institute (AARI). A detailed report (CDCN #97-V07 "Vegetable Trials") is available upon request. Trials were conducted on site and included the following:

Broccoli cultivar evaluation - 7 broccoli cultivars were succession seeded for early, mid and late season harvests and evaluated for yields, quality and maturity. Two new promising cultivars were Republic and Barbados, they were significantly better than the industry standards Emerald City, Patriot and Arcadia.

Cauliflower cultivar evaluation - 9 cultivars of cauliflower transplants were succession planted for early, mid and late season harvests and evaluated for yields, quality, earliness and lateness. Iceman performed well in all planting dates. Pathfinder and Arctic were earlier maturing cultivars of excellent quality. Iceman produced excellent quality of good weight and uniform maturity for mid and late plantings.

Mid-season cabbage cultivar evaluation - 45 cultivars of mid season cabbage were transplanted May 29 and evaluated for yields, maturity, quality and physical properties for sauerkraut and cabbage roll potentials. Sprint Ball, Parel and Manoko were the earliest maturing of excellent quality. Cecil showed excellent physical qualities for sauerkraut, while Southern Pacific showed excellent physical qualities for cabbage rolls.

Pickling cucumbers cultivar evaluation - 12 cultivars of pickling cucumbers were direct seeded and evaluated for yields, maturity and quality. Calypso and Cross Country were excellent quality, high yielders. They were closely followed by a small vining plant called Baby Bush and a variety called Salty.

Zucchini cultivar evaluation - 12 cultivars of zucchini were direct seeded on May 9 and evaluated for yields, maturity and quality. Most cultivars matured at the same time and produced excellent quality. Monet was an excellent yellow zucchini producing the highest number of fruit per plant throughout the entire season. Of the green cultivars, Seneca and Clairmore were the earliest to produce the largest number of fruit per plant; and to continue producing large numbers of fruit throughout the harvest period.

Leek fall seeding versus spring seeding versus spring transplants - 7 cultivars were direct seeded in October 1996 and compared to 1997 spring direct seeding and spring transplanting. The spring transplants produced the highest yields and best quality. Yields and quality in the fall direct seeding was the worst. Again Titan produced the highest yields of excellent quality on all planting dates.

Radish succession seeding cultivar evaluation - 17 cultivars were direct seeded starting May 1 and succession seeded every two weeks thereafter until October 16. Early maturity, quality and yield were evaluated. Altabelle was the top performing in all plantings, closely followed by Poker and Winter Green.

Beets succession seeding/cultivar evaluation - 12 cultivars of beets were direct seeded May 8, June 3 and

June 16 and evaluated for quality and yields. The overall top performing cultivar with largest yields continued to be the industry standard Detroit Dark Red Medium Top. It was closely followed by Red Ace.

Jerusalem artichoke cultivar evaluation - the cultivars Stampede and Challenger were planted in the spring of 1996 and harvested in September 1997. Both cultivars produced good quality. However, yields produced by Challenger were three times greater than yields produced by Stampede. Challenger also had a smoother, light coloured skin that was easier to clean and was not as woody tasting as Stampede.

Hulless pumpkin production trial - the cultivar Sentesi Futo was grown for production evaluation for pumpkin seed potential. Transplants were used. Maturity was less than 50 percent in all plants at time of harvest. Seed maturity inside the pumpkin varied from 10 to 90 percent.

Mini ornamental corn production trial - the cultivar Chinook was seeded and evaluated for production potential. Approximately 80 percent of the plants produced nice quality mini ornamental corn. The remaining 20 percent produced cobs with no tip fill.

Pumpkin production trial - the cultivar Baby Bear was grown and evaluated for production potential. All plants produced excellent quality baby pumpkins. Mice and slugs were also attracted to the pumpkins and caused minor scarring.

Garlic fall versus spring planting cultivar trial - 13 cultivars of garlic were fall planted in 1996 and compared to a spring 1997 planting. The fall planting performed better than spring planting. Legacy, Music, Siberia and Vernon continued to produce good quality high yields.

Carrot density trial - the cultivar Touchon was direct seeded with a precision seeder at three different seeding densities. A Stanhay precision seeder was used to seed 1) a twin line, 90-90 belt, 3" wide coulter; 2) a triple line, 90-72-90 belt, with a 3" wide coulter; and 3) a triple line 90-72-90 belt with a 4" coulter. An early and a late harvest was done. The triple line with the widest coulter produced the highest yield of carrots that were very uniform in size and shape, had good tip fill and excellent quality.

Research Cooperative trials continued:

1) Integrated Control of Fungal Root Rots and Root Maggots in Cole Crops with Dr. Kan-Fa Chang.
2) Developing Appropriate Post-harvest Cooling and Handling Systems for the Horticulture Industry in Alberta with I. Edeogu, Engineering Department.
3) Cooperated with Dr. Janet Panford, Food Scientist, in research with the Gimbel Eye Centre on Beta Carotene levels of various vegetables.

Technology Transfer Services

Extension activities focussed on education and technology transfer to growers in all aspects of fresh vegetable field production possible under Alberta growing conditions, and in providing product handling information needed to sell these crops.

Consultation, diagnostics, problem solving and technology transfer to growers was maintained. Grower phone calls and office visits continued. On-site farm consultation was limited to an "as needed" basis. Technical information was transferred to growers through direct contact, courses, talks and workshops. Seminars were done jointly with the vegetable program from CDCS on research trial results and production updates. Soil fertility recommendations to growers continued.

Grower use of specialized equipment was limited and focussed on group use and demonstrations. Close liaison continued with Alberta Market Gardeners' Association and other industry personnel. A talk was presented on root maggot controls at the technical sessions at the Alberta Horticultural Congress.

Industry involvement in the program's extension services continued to increase. The Alberta Market Gardeners' Association (AMGA) sponsored a grower production seminar, fertility workshop and direct marketing workshop. The well established industry newsletter has been active in using technical information produced by the vegetable program and transferring it to the industry and producers. This organization

has become a strategic partner in the development and growth of the industry by: educating its producer members; actively promoting the industry; increasing consumer awareness and by ultimately increasing the demand for Alberta produced vegetable products.

Involvement in the Fall Harvest Festival continued. This is a sub committee under the Northern Alberta Produce Marketing Association that promotes the Alberta Fresh Vegetable Industry.

Actively participated on the Veggie Action Team; a sub-committee of the Horticulture Product Team. This team addressed industries concerns and acted upon them. Actions included reports on a Vegetable Supply Chain Analysis study, A Cost Competitive study for several crops and fact sheets resulting from these studies, plus the organizing of a post/harvest marketing conference and precooling workshop.

Consultation and liaison with other segments of the department continued: including rural development specialists regarding production courses; Marketing Department; Financial Services Corporation regarding producer loans. As well, extensive cooperation and liaison with the Department's Engineering Services in designing a small precooler unit for fruits and vegetables continued.

Vegetable Crops Program (Brooks)

P. Ragan and W. Johnson

Applied field research and extension activities are designed to serve market gardeners, large-scale fresh vegetable growers, and contract processing growers. Variety adaptation and earliness enhancement of crops through improvements in cultural management practices are the main research activities of the vegetable program. Technology transfer is carried out through on-farm visits and participation in commodity organization conferences and workshops.

Research Projects

Variety adaptation

Details of results on varieties tested are reported in the CDCS Pamphlet #98-5 *Vegetable Variety Adaptation Trials 1997*. Pamphlet copies were supplied to the 30 participating seed companies. Workshops were held across the province in November to discuss findings and make recommendations to producers. These workshops also provide opportunities for producers to direct research toward areas of concern.

Approximately 500 varieties of 17 types of vegetables were evaluated. In addition, succession plantings of direct seed and transplant cauliflower and broccoli varieties were evaluated. Storage quality observations on all carrot and onion varieties continued up to 6 months after harvesting.

Production management trials

Details of results on production management trials along with summaries are reported in the CDCS Pamphlet #98-4 *Vegetable Production Trials 1997*. A brief description of production trials follows.

Celery planting date and depth of planting

Celery is a late sizing crop in Alberta and earlier plantings are required to enhance market availability. Early planting runs the risk of low temperature and frost exposure which can induce bolting. This trial was conducted to assess celery response to earlier planting.

A randomized complete block trial included the following treatments:
Cultivar - Tendercrisp and Improved Utah 5270
Planting Date -
early April 29 with a normal planting depth
early April 29 with a buried crown planting
late May 29 with a normal planting depth

All treatments were randomized in a three replicate trial. Five plants from each treatment were harvested as follows:
early plantings:
August 30 123 days after planting
September 13 137 days after planting.

late plantings:
August 30 94 days after planting
September 13 108 days after planting.

In terms of planting date and method of planting, these findings were observed:

1. Even with a late April planting and follow-up freezing temperatures of -0.8° May 2, -1.0° May 3, -0.6° May 5 and -2.1° on May 8, no appreciable amount of bolting was observed in any variety or planting treatment. Crown burial provided no additional low temperature protection to the growing point which impacted bolting incidence.
2. The buried crown treatment proved to be more difficult to harvest. The harvest knife met resistance entering the soil low enough to sever roots from the crown, a critical point at which leaf stalks are held together.
3. The late May planting date resulted in significantly lower yields overall and in individual plant weights. A late April planting appears feasible and certainly provides economic advantages through early market access.

Observations related to varietal response indicated:

1. Based on planting date comparisons, earliest marketable stalks were available in Ventura followed by Tango. Improved Utah 52-70 was the slowest to size up.
2. Heaviest production at a late harvest can be expected with Tango, followed by Triumph. Both Tendercrisp and Improved Utah 52-70 yielded the lowest.
3. Longest stalks at early and late harvests were produced by Ventura followed by Tango. Improved Utah 52-70 had the shortest stalks.
4. Crown diameter benefited from early planting. Both Ventura and Tango produced the largest crowns only at an early harvest date indicating they possess early maturing characteristics which was also reflected in longer stalk length.

Jumbo onion production

Jumbo grade onions are not grown commercially in Alberta from seed as the short season hinders full maturity. Limited success can be achieved with some selective cultural methods. This trial was designed to investigate the possibilities.

A randomized complete block trial layout was used in this trial with the following treatments:
Cultivar Eskimo and Tarmagon were selected because of their early maturity.
Density a Stanhay Mark II drill with twin-line shoes was equipped to drop sufficient seed to provide a hand thinned count of 25 and 45 plants per metre row length.

The trial failed to achieve its major objective, the production of jumbo grade bulbs. This outcome is probably due to plant densities still being too high. Nevertheless, the following observations on onion production can be made:

1. Earlier maturity occurs as plant density increases.
2. Overall yield increases as plant density increases, however, bulb size decreases as a consequence.
3. Jumbo grade bulbs cannot be produced with success in twin-line plantings and perhaps single-line plantings is the way to go.

Cut and peel carrot plant density

Development of the baby carrot market which utilizes a cut and peel process on fresh pack carrots has led to interest in cultural management of a crop that produces a long, non tapering root. The objective of this trial was to do a preliminary investigation into the responses of cultivars in multi line seeding at various plant densities.

A complex factorial trial which included a number of treatments was used at this preliminary level. Treatments were as follows:

Cultivar	Indiana, Newport, Plato and Nashville were selected because of their favourable root shape characteristics.
Line	a double and triple line seeding treatment utilized the capability of the Stanhay Mark II seed drill.
Density	a hand thinned count of 70, 100 and 150 plants per metre row was established.

The results of this trial failed to show any interactive effects between line, variety and plant density treatments. As treatments on their own, the following observations were shown to be of significance:

1. Total yield alone is not impacted as there is a redistribution of yield of each grade so that:
   a. #1 yield rises with increased plant density.
   b. jumbo yield rises as plant density decreases.
2. Root length increases as plant population decreases.
3. The degree of variation in root length increases as plant population decreases.
4. Variety response differences are minor with most varieties being relatively similar in growth habit as plant density and line seedings change. Genetics plays a major roll in determining crown diameter and root length characteristics.
5. Double- and triple-line seeding has no differential impact on total production (yield) of cut and peel carrots.

Romaine lettuce spacing trial

Of all the lettuce types, romaine has the best market potential in Alberta. This trial investigated this crop's performance at variable in-row spacings over three successive seedings.

In a randomized complete block trial, the varieties Parris Island and Valmaine were direct seeded and thinned to between plant spacings of 15, 30 and 45 cm. This same process was repeated twice more. Seeding dates were April 18, May 28 and June 25.

In the production of romaine lettuce and hearts as it relates to in-row spacing practice, the following was observed:

1. Parris Island is superior to Valmaine in yield and quality.
2. Closer in-row spacing of 15 cm compared to 45 cm enhances maturity, however mean head and heart weight decreases.
3. There is greater variability in head weight as in-row spacing increases.
4. Recommended in-row spacing will be determined by market requirements for romaine head and heart weight.

Nitrogen and phosphorus rate influence on garlic production

This trial investigated the effects of nitrogen and phosphorus on both the yield and bulb size of garlic.

A simple randomized complete block trial was used with the following treatment:
Cultivar: Laszlo, a proven cultivar, a soft-necked artichoke type.
Fertilizer: nitrogen at 0, 100 and 300 lb per acre, phosphorus at 0 and 200 lb per acre with a 100 x 200 NP interaction treatment.

This trial showed that garlic is not a very responsive crop to nitrogen and phosphorous. Perhaps soil nutrient reserves were already adequate (not measured).

Although yield was not influenced there was some indication that bulb weight, diameter and clove number per bulb increased when both nitrogen and phosphorous were applied together rather than individually. A combined nitrogen x phosphorous requirement in garlic may exist.

Technology Transfer Services

A one-to-one, on-farm extension service was provided to producers in the southern region of the province. Specialized equipment was loaned to producers to encourage adoption of new technology. Popular items included: two precision drills, transplanters and plasticulture equipment. Program staff also provided the seed belt punching and calibration service for producers using Stanhay seeders. Seed lots are matched with the best combination of belt hole size and number of holes to ensure optimum plant density in the field.

Annual workshops for vegetable producers were given to provide variety recommendations and guidelines to data interpretation as reported in the CDCS pamphlets 98-4 and 98-5. These workshops also provide an opportunity for growers to direct research programs.

Special activities included:

1. Vegetable growers field day at CDCS.
2. Tour of two wholesale facilities in Calgary by vegetable growers.
3. Tour of vegetable research plots at CDCS by all produce buyers for Canada Safeway western Canada division.
4. Supply chain linkages between growers and produce buyers were established for the 1998 season.

The Processing Vegetable Growers Newsletter was edited and posted quarterly.

New Crop Development Unit

This unit operates research, technology transfer and service programs in agronomy, plant breeding, soil and water management, food science, weed science, plant pathology and post-harvest technology. Support is provided to other research programs at CDCS and CDCN and to agricultural industries, producers and processors in Alberta.

Research and technology transfer programs are conducted in cooperation with the federal, private industry and university scientists. Close working contacts are maintained with various agricultural and scientific organizations outside Alberta.

Food Science and Technology Program

J.A. Panford, L.R.J. Dowdell and J.A. Calderon

The food science and technology program conducts applied research into current and emerging technologies in post-harvest handling, storage and value-added processing of horticultural and special crops. Findings are transferred to Alberta's horticultural and special crops processing industries through presentation of research results at seminars, workshops and conferences and in trade and scientific publications. In addition, the program supports all crop production research programs at CDCS by carrying out chemical analyses and sensory evaluations on new and existing cultivars/varieties of fruits, vegetables, potatoes, pulses, herbs and spices.

Research Projects

Process and product development: native fruit quality

The program began a two-year study involving the evaluation of the organoleptic characteristics of four saskatoon berry cultivars for commercial processing. The most widely grown cultivars Smoky, Northline, Honeywood and Thiessen were selected for this study. Both growers and processors are interested in knowing which cultivar is best suited for products such as jam, jelly, syrup and pie filling and why. Attributes such as appearance, taste, texture and overall acceptability are being assessed for each cultivar and comparisons will be made in 1998. This project is jointly funded by AARI, Fruit Growers Society of Alberta, Saskatchewan Fruit Growers Association and Prairie Fruit Growers Association of Manitoba.

Analytical chemistry: nutraceuticals

The program completed a two-year study involving the development of an analytical method for identifying and measuring amounts of carotenes and xanthophylls in spinach, kale, carrots, romaine lettuce, swiss chard and beet greens. Lutein, zeaxanthin and beta-carotene were isolated and quantified. Results indicate that:

- the concentration of beta-carotene, lutein and zeaxanthin in Alberta-grown vegetables were comparable to levels reported for the same commodities in other parts of the world;
- vegetables grown in north-central Alberta (CDCN) had higher lutein levels than those grown in the south (CDCS).

A final report is being prepared. This project was jointly funded by AARI and the Gimbel Eye Centre in Calgary.

Service to Other Programs at CDCS

Program staff evaluated the quality of vegetables, potatoes and special crops for their suitability for commercial production, processing and consumption.

- Essential oils extracted from herbs and spices grown by the special crops program were analysed for hydrocarbons by gas chromatography. Crops tested included basil, coriander, caraway, hyssop, peppermint, spearmint and Alaskan mint. Results will be used in selecting cultivars for commercial production and processing.
- In support of the Prairie Potato Breeding Program, Agrium and Dr. Colin McKenzie's Site-Specific Farming studies, over 1100 potato cultivars and selections were processed and evaluated for their french fry, boiling, baking and chipping quality. Total glycoalkaloid content of selected cultivars was also determined. The results will be used in selecting cultivars for commercial production and processing.

Technology Transfer Services

Existing and potential processors were provided assistance with process and product development, on-site visits for process diagnosis, product development, technical advice and sensory evaluation. Research results were disseminated to interested parties through presentations at industry and scientific conferences, seminars, workshops, annual reports and publications.

The Program Leader attended and participated in AAFRD Horticulture Product Team meetings throughout the year. The Program Leader presented research results at the Alberta Horticultural Congress and at the annual conferences of Fruit Growers Society of Alberta, Saskatchewan Fruit Growers Association, and Prairie Fruit Growers Association of Manitoba.

Plant Pathology Program

K.F. Chang, R.J. Howard, and M.A. Briant

The plant pathology program has a mandate to conduct applied research on important diseases of horticultural, forage and specialty crops. These studies encompass field, laboratory, growth chamber and greenhouse experiments, as well as disease surveys. Findings from this work and from the research of other scientists are presented to commercial producers through technology transfer programs. Service is a third activity that primarily involves support to crop production research programs at CDCS. Some plant pathology projects are also discussed in the report of the post-harvest technology program.

Research Projects

Diseases of Special Crops

Screening dry beans for resistance to root rot and leaf blight diseases

Thirty-one cultivars and lines in the Prairie Regional Dry Bean Co-op Trial were tested for resistance to bacterial blight [*Pseudomonas syringae* pv. *syringae* (Pss), *P. s.* pv. *phaseolicola* (Psp), *Xanthomonas campestris* pv. *phaseoli* (Xcp) and Xcp fuscous strain (Xcpf) and root rot pathogens [*Fusarium oxysporum*, *Rhizoctonia solani* and *Pythium ultimum*]. The results were used by the Prairie Registration Recommending Committee for Grain, Subcommittee on Special Crops, to support the registration of new lines for commercial production. In the fusarium root rot screening test, L94D186, Apache and 94138 had significantly better

performance than the standard cultivars. Among the entries tested for resistance to *R. solani*, L94D156, L94D186, L94D261 and L94D303 were significantly better than NW63 for root rot severity, plant fresh weight, root dry weight and plant height. For pythium root rot, only Apache and 94138 had lower root rot severity, higher plant fresh weight and root dry weight than the standard cultivar Othello. Amongst Red Mexican beans, L94D312 and L94D303 were significantly more resistant to Psp than NW63 and the other entries. In the Pinto, Pink and Kidney categories, there were no significant differences in bacterial blight resistance between entries. Amongst Great Northern entries, L94E137 had significantly more resistance to Pss than did the standard US1140.

Effects of chemical seed treatments on emergence, uniformity, vigour and nodulation in six types of dry beans in greenhouse and laboratory trials

Three separate experiments were set up to assess potential phytotoxic effects of two fungicides, Captan and Thiram, alone or in combination with the bactericide Agricultural Streptomycin, on six types of dry beans (pinto, red mexican, great northern, pink, black and navy) at CDCS. These experiments assessed: 1) bean emergence and growth under greenhouse conditions, 2) germination and radicle length under laboratory conditions, and 3) nodule development under greenhouse conditions. Eight chemical treatments, which were comprised of one rate each for Captan 400 and Thiram 75 WP alone and three rates of Agricultural Streptomycin in combination with one rate each for Captan 400 and Thiram 75 WP, were evaluated. An untreated check was included for comparison. The chemical treatments generally had negligible effects on bean emergence and growth under both greenhouse and laboratory conditions. There was a slight negative effect of the different fungicides on nodulation. The navy bean was the only type to demonstrate significantly higher levels of nodulation for the Thiram- versus Captan-containing treatments. No significant differences were observed amongst the other bean types, but all of them seemed to show a slight increase in nodulation with Thiram seed treatment.

Evaluation of fungicide seed treatments for the control of root rot diseases of field pea

Carneval and Carrera peas were seeded at Brooks and Vegreville, respectively. Seed was treated with Apron XLS or Apron FL. Inoculum containing a mixture of *Pythium ultimum* and *P. irregulare* was incorporated at the time of seeding at the rate of 40 mL/row. No significant ($P \leq 0.05$) differences in seedling emergence, root rot severity, or seed yield were observed between the two fungicidal seed treatments for either cultivar at either location. Neither fungicidal seed treatment had an effect on root rot severity at either site. Both treatments significantly increased yield in Carneval at both locations and Carrera showed higher yields. Inoculation with the *P. ultimum* - *P. irregulare* mixture significantly reduced emergence in Carrera and yield of Carneval at both locations. Both fungicidal seed treatments generally had a positive effect on emergence and yield, but neither significantly reduced root rot severity.

Efficacy of fungicidal seed treatments for the control of ascochyta seedling blight on chickpea

Two lots of Kabuli-type (UC27) chickpea seeds naturally infested with *Ascochyta rabiei* were planted at Vegreville and Brooks. Fungicide treatments consisted of Crown + Apron, Apron alone and an untreated control. Both fungicides showed significantly ($P \leq 0.05$) greater seedling emergence than the untreated control at both Vegreville and Brooks. The results from both sites indicated that Apron provided effective protection against soilborne pathogens. The Crown + Apron treatment showed higher seedling survival at Vegreville, indicating that Crown had the potential to provide additional protection against seed- and soil-borne diseases compared to Apron alone.

Efficacy of seed treatments for the control of pythium root rot on chickpea

Marango (Desi-type) and UC27 (Kabuli-type) chickpeas were planted at Brooks and Vegreville, respectively. *Pythium ultimum* and *P. irregulare* inoculum was mixed and incorporated with the seed. Treatments consisted of Crown + Apron at two rates, Apron at two rates and an untreated control, with and without *Pythium* inoculum. All fungicidal treatments significantly improved seedling emergence for the Kabuli type, and fungicidal treatments containing Crown improved seedling emergence for the Desi type.

Efficacy of seed treatments for the control of fusarium root rot on chickpea

Desi-type chickpea was planted at Vegreville and Brooks. Inoculum of *Fusarium avenaceum* was incorporated with the seed. Treatments consisted of Crown + Apron at two rates, Apron alone and an untreated control, with and without *Fusarium*. At Vegreville, all fungicidal treatments significantly ($P \leq 0.05$) improved seedling emergence relative to the *Fusarium* treatment, and plots treated with Crown + Apron at the lower rate had significantly better seedling emergence than those treated at the higher rate. At Brooks, fungicidal seed treatments that included Crown significantly increased seedling emergence over treatment with Apron alone and over plots without fungicidal seed treatment. Similar trends occurred in seed yield, although no significant differences were observed among fungicidal treatments. Results from both sites showed improvement in seedling emergence and seed yield when seed treatments that included Crown were used. Apron alone was effective at Vegreville, but not at Brooks.

Efficacy of seed treatments for the control of botrytis blight on chickpea

Two *Botrytis*-infested seedlots of kabuli-type chickpea cv. Sanford were planted at Brooks and Vegreville. Treatments consisted of Crown + Apron at two rates, Apron alone and an untreated control. At Vegreville, the fungicidal treatments significantly ($P \leq 0.05$) improved seedling emergence for both seedlots. At Brooks, the high rate of Crown + Apron did not improve emergence over the control, but the other fungicide treatments did. Seedlot #1 showed significantly higher seed yield than the untreated control where seeds were treated with Apron or with Apron + Crown at the lower concentration. Results from both sites showed improved emergence when infected chickpea seed was treated with Apron and Crown + Apron at the lower concentration. Crown mixed with Apron did not improve emergence of *Botrytis*-infested seed relative to Apron applied alone.

Evaluation of Crown fungicide as a control for fusarium root rot of lentil

Lentil cvs. 512, Laird and Redwing were seeded at Brooks and Namao. Crown fungicide was applied at two rates, along with *Fusarium*-inoculated and non-inoculated controls. Both fungicide seed treatments significantly ($P \leq 0.05$) improved the average number of emerged seedlings for all cultivars over the inoculated controls at Brooks, whereas, at Namao, Crown improved the emergence only at the higher rate in Laird and at the lower rate in Redwing. Seed yield was significantly higher in the noninoculated control compared to the inoculated control at both sites for all cultivars. Crown at the lower rate significantly improved seed yield in inoculated 512 lentils at Brooks but not in Laird or Redwing. At Namao, both treatments significantly improved seed yield in the 512 lentils, but not in the other two cultivars. Application of Crown at 6 mL/kg did not improve its efficacy over 3 mL/kg for either seedling emergence or seed yield, but improved seedling emergence over the inoculated control. The reduced plant stand did not translate into lower seed yield in many cases because the remaining healthy plants were able to compensate by producing more seed per plant in the thinner stands, the only exception being 512 at Namao. Lower levels of emergence in the inoculated relative to the noninoculated controls suggests that the introduced inoculum played a major role in inducing seedling damping-off.

Evaluation of diseases on coriander

Thirteen seed lots of coriander from dryland and irrigated fields in Alberta and Saskatchewan were tested for contamination with microorganisms using blotter and agar plate methods. Seeds were left non-sterilized or were surface sterilized with 1% bleach solution for 3 minutes before they were placed onto filter papers or potato dextrose agar plates. The major species of microorganisms isolated were *Alternaria* spp., *Cladosporium* spp. and bacteria. Over 98% of the seeds were contaminated with *Alternaria* spp. in all samples. Bacteria colonies were increased and *Cladosporium* spp. were decreased after surface sterilization. The effect of temperature on germination of the above-mentioned seed sources was assessed in soilless medium in pots placed in a growth chamber at 15°C. Germination rates for each variety were higher in seed from dryland versus irrigated fields, indicating that irrigation may encourage fungal colonization of seeds. Surface-sterilized seeds had the same germination rate as nonsterilized seeds, suggesting that some microorganisms had become established inside the seed.

The occurrence of ginseng diseases in Alberta in 1997

Eleven ginseng fields were surveyed for disease incidence (DI) and severity (DS). DS and DI varied with location and age of the crop. DI ranged from 2.5-77.4%, while DS generally was low and ranged from 0.05-2.14 on a scale of 0-4. The highest DI (77.4%) occurred in a 4-yr-old planting at Carmangay and second highest was observed in a 4-yr-old garden at Rosemary. Generally speaking, DI and DS were higher in 1997 than 1996. Damping-off and root rot were common in 1-year-old seedlings in gardens at Athabasca and Lacombe. *Pythium* spp., *Phytophthora* spp, and *Rhizoctonia solani* were isolated from root and crown areas. *Alternaria* spp. were the predominate organisms isolated from lesioned leaves, followed by *Fusarium* spp. and bacteria. *Fusarium* spp. were the major cause of stem and root infections, but bacteria and *Alternaria* spp. were also involved. Leaves with interveinal chlorosis symptom similar to those caused by nutrient deficiencies were observed in a garden at Ardmore; however, soil and tissue analyses of symptomatic leaves revealed a normal range of nutrients in the samples, suggesting that the symptoms were induced by flooding. Powdery mildew was found in two fields and *Botrytis cinerea* and *Sclerotinia sclerotiorum* were isolated from leaves and stems for the first time in Alberta.

Species, leaf wetness and temperature effects on mint rust development

Twenty-four *Mentha* species and cultivars were inoculated with urediospores to determine their reaction to *Puccinia menthae* Pers. in growth chambers at 15/8, 20/10, 25/14 and 30/18°C with a 12 h photoperiod. *M. alaska* and *M. spicata* were highly susceptible, followed by *M. arvensis*, *M. piperita* and *M. pulegium*, under the first three temperature regimes. The rest were immune. A few small uredia were produced at 30/18°C on susceptible mints. The latent period for *P. menthae* ranged from 12-15 days at 25/14 and 20/10°C, 16-24 days at 15/8°C, and 30 days at 30/18°C, depending on cultivar. Inoculated plants were placed in a moist chamber for 2-48 h to determine optimum duration of leaf wetness for infection. Maximum uredia formed after 36 h of wetness at 18°C, but very few formed after 4 h. The effect of temperature mint spore production was assessed using the four temperature regimes mentioned above (day/night, 12 h). Infected *Mentha spicata* plants were moved to growth chambers at the specified temperatures when uredia had just begun to sporulate. Spores were collected from the same leaves weekly. The most urediospores were produced at 25/14°C, followed by 20/10, 30/18 and 15/8°C, during a 5-week period. Four percent of teliospores was formed from uredia after sporulated plants were exposed to 15/8°C for 3 weeks. Teliospores numbers increased dramatically to 34.3% and 65.6% of total spore production after four and five weeks of incubation, respectively. At 20/10°C, 0.01% and 3.4% teliospores were formed from uredia in the fourth and fifth week of incubation, respectively. No teliospores were produced when infected plants were grown at 25/14°C.

The occurrence of *Sclerotinia sclerotiorum* on stevia and its chemical control

A study on fungicidal control of sclerotinia rot of stevia was conducted in a greenhouse at CDCS. This disease can significantly reduce foliar growth and stevioside production. Four-month-old plants propagated from seed were inoculated with three mycelial discs of *Sclerotinia sclerotiorum* and placed in a humid tent for one week. Plants had just started to show wilt symptoms by this time when groups of 20 were drenched with 20 mL of the following fungicides: Benlate 50% WP, Botran 50% WP, Easout 70% WP, Ronilan 50% WP and Rovral 50% WP. Twenty untreated plants were kept as a control. After the first drench, some plants continued to show wilting symptoms. Ten plants were drenched with each fungicide for a second time. Approximately 80% of the control plants had died shortly after the first application of fungicides. Dead plants showed bleached stems, which did not often occur under field conditions. Two fungicide applications were required to control the disease.

New diseases of *Echinacea* spp. in Alberta

In October, 1996, sclerotinia stem rot disease was observed in a research plot of 6-month-old echinacea plants at CDCS. Diseased plants showed dark brown to black stem lesions above and at the soil level and dead leaves with bleached petiole lesions. Roots were rotted and black. Superficial white mycelium developed over the basal part of affected stems. Black, oblong to irregular-shaped sclerotia, 5.1-17.6 mm in size, formed externally on the crown areas after plant death. *Sclerotinia sclerotiorum* was isolated from the diseased plants. In May 1997, Botrytis blight was observed in a commercial field of 3-year-old *E. pallida* var. *angustifolia* plants in Vernon, BC. Diseased plants had small to large, brown or black lesions on leaves and stems. Pathogenicity of both fungi were confirmed through artificial inoculations in the greenhouse. A disease survey was conducted on one- and two-year-old echinacea crops in eight fields at five locations in Alberta during August and September. Disease incidence (DI) and severity (DS) were determined visually. DI ranged from 5.4-84% and DS ranged from 0.1-3.4 on a 0-4 scale. The major pathogens were *Sclerotinia sclerotiorum*, aster yellows phytoplasma, *Alternaria* spp. and *Fusarium* spp. *Alternaria* spp. were mostly isolated from diseased floral stalks and *Fusarium* spp. from infected roots. These diseases could have a significant impact on the longevity and productivity of this crop.

A yellows disease of calendula, caraway, monarda and valerian caused by a phytoplasma

Phytoplasma-induced yellows diseases were discovered on calendula, caraway, monarda and valerian in southern Alberta. Leaf reddening, chlorosis, plant stunting, proliferation of axillary shoots and malformations of floral parts involving virescence and phyllody were observed in research plots at CDCS in 1996. Transmission electron microscopy revealed phytoplasma bodies in sieve tube elements in diseased plants but not in healthy ones. Their diameters varied with the host, but most were oval to spherical, lacked cell walls and were surrounded by single membranes. Using the polymerase chain reaction (PCR) and phytoplasma universal primers, an amplification product of the expected size (558 bp) was observed in samples from infected but not asymptomatic plants. This is the first report of phytoplasma diseases on these crops in Canada.

Diseases of Forage Crops

Efficacy of two insecticides against silvertop on four cultivars of Kentucky bluegrass

Insecticide efficacy trials were conducted in experimental plots of cvs. Asset, Barcelona, Midnight and Cynthia Kentucky bluegrass at CDCS. Cygon 4E and Decis 50EC were applied on May 5, May 16 and June 9 and check plots were not sprayed. The May treatments were applied pre-heading and the June sprays at early heading. Silvertop incidence levels were high to very high in all four cultivars. Decis was more effective in reducing silvertop incidence than Cygon. Insect and mite pests can incite silvertop directly and may also vector bacteria and fungi causing silvertop or predispose grass plants to natural infection by these microorganisms. This study pointed out the importance of early, i.e. pre-heading, application of insecticides. Further work is required to determine optimal timing and frequency of application.

Diseases of Vegetable Crops

Effects of fungicides and insecticides on rhizoctonia root rot of cauliflower

Cauliflower seedlings, cv. Fremont, were grown in field to study the effect of five fungicides and three insecticides treatments on the development of rhizoctonia root rot and on productivity of cauliflower. Overall, stems from fungicide-treated plots had shorter lesion lengths than in untreated plots. Average weight per head was significantly greater for Terraclor and Bravo treatments than for the untreated control. A lower disease severity was noted in plots treated with Benlate compared to those treated with Zineb. Results of the insecticide study indicated that all treatments significantly reduced lesion length and disease severity, and increased total harvest and individual head weight. Diazinon and Lorsban, when combined with Benlate, resulted in significantly shorter lesions than when Benlate was used alone.

Evaluation of cauliflower cultivars for resistance to rhizoctonia root rot

Twenty-one cauliflower cultivars were screened for resistance to *Rhizoctonia solani* under field conditions. Significant differences in stem lesion length occurred between plants in the inoculated and noninoculated treatments. Lesion length in Yukon was significantly longer than in cvs. Minuteman, Bur-Queen, Cashmere, Bishop and Snowball. Head weight was significantly lower in Vio-Queen and Bur-Queen compared to the other cultivars.

Diseases of Potatoes

Late blight survey in southern Alberta

A potato late blight survey was conducted on August 7 by C. Shaupmeyer, E. Van Dellen and M. Briant. Ten fields (335 ha) were surveyed in southern Alberta. A few samples with symptoms resembling those of late blight were sent to Dr. B. Platt in Charlottetown, P.E.I., but none were positive for late blight.

Technology Transfer Services

Program staff spoke at six growers' meetings and workshops in 1997. Eleven scientific papers, seven abstracts and twelve miscellaneous reports were published. Staff were involved in the activities of several professional societies and advisory committees.

Assistance was provided to Brooks Diagnostics Limited to diagnose several dozen plant disease specimens. As well, advice on disease identification and management was provided to CDCS staff as requested.

R.J. Howard retained an appointment as an Adjunct Professor in the Department of Agricultural, Food and Nutritional Science at the University of Alberta, and was involved in Departmental activities included lecturing, diagnostic consultations and cooperative research. He also served as President of the Canadian Phytopathological Society in 1997/98.

Post-harvest Technology Program

J. D. Holley, S.I. Lisowski and C.C. Toews

The primary objective of the post-harvest technology program at the CDCS is to maximize the longevity and quality of stored horticultural crops. Research and extension efforts are both directed towards improving storage management practices used in industry today. In addition to this, the program screens advanced breeding lines from the Prairie Potato Breeding Program every year for resistance to early blight, verticillium and fusarium wilt, and to a range of storage diseases.

The post-harvest technology program initiated several interesting new projects in 1997. It began evaluating wild relatives of potato, i.e. diploid species of the genus *Solanum,* in replicated field plots to see whether genes from any of them could be incorporated into advanced breeding lines to increase their levels of early blight resistance. It also started a multi-season, cross-Canada experiment designed to see if applying fungicides to potato foliage during the summer increases resistance of tubers to serious storage diseases. Finally the program continued to work with alfalfa blossom blight.

Research Projects

Field Trials

Early blight resistance screening

Small plots of two standard cultivars and thirty advanced breeding lines from the Prairie Potato Breeding Program were established in a randomized complete block design with four replicates in soil that was heavily infested with spores of the early blight fungus, *Alternaria solani*. The percentage of each row infected with early blight was estimated for each small plot several times during the summer. All observations were subjected to an analysis of variance and means for each cultivar/line compared using "T" and Duncan's tests. Analysis showed that two lines had as much or less blight than the resistant standard, Russet Burbank, seven had as much or more blight as the susceptible standard, Warba, while the remaining lines showed intermediate levels of resistance.

Screening species from the genus *Solanum* for new sources of early blight resistance

Diploid species from the genus *Solanum*, wild relatives of potato, are known to be highly resistant to a number of serious potato diseases. Genes for disease resistance from these diploids can easily be incorporated into the potato genome, so they are a valuable resource for the potato industry. The Post-Harvest Technology Program started to evaluate diploid lines in cooperation with the Prairie Potato Breeding Program in replicated field trials for the first time this summer to see how resistant they were to early blight. Diploid plants showed almost no early blight symptoms just prior to the first hard frost at the end of September. By contrast, early blight had completely defoliated adjacent rows of Warba two weeks earlier. Because diploids mature much more slowly than any cultivar or breeding line, it was not clear whether they were exhibiting a highly resistant response to infection or were simply too immature to show symptoms. This trial will be planted much earlier next season.

Verticillium wilt resistance screening

Virulent cultures of two potato wilt pathogens, *Verticillium albo-atrum* and *V. dahliae*, were grown on barley seed three weeks prior to planting. Two cultivars and fifteen advanced breeding lines were planted in an eight replicate randomized complete block field trial with infested grain. Fifty tubers from each replicate were cut and examined for evidence of vascular browning from wilt infection after harvest. Percentages of tubers with symptoms were recorded and means calculated for each line. Data were analysed as described above for early blight. One test line had less and three others as much discolouration as the resistant standard, Russet Burbank. Two lines had more and five lines had as much vascular browning as the susceptible standard, Shepody. Four lines had intermediate levels of disease resistance, i.e. higher levels of vascular browning than Russet Burbank but less than Shepody.

Fusarium wilt resistance screening

A virulent culture of *Fusarium oxysporum* was established and used to plant and inoculate two cultivars and fifteen advanced breeding lines in a second wilt screening trial using the method described in the previous paragraph. Results were recorded, means calculated and data analysed as described previously. Two lines had less vascular discolouration and four as much as the resistant standard, Russet Burbank. One breeding line had much more vascular browning than the susceptible standard, Shepody. Eight lines showed intermediate levels of disease resistance.

Survey for alfalfa blossom blight

In 1997, a simple technique similar to the one used to identify *Sclerotinia sclerotiorum*, the first of two blossom blight pathogens was developed for the second, *Botrytis cinerea*. Twenty-five growers in southern Alberta and in the Peace River region were given disease detection kits and asked to use them to document levels of infection for both pathogens at early, mid and late bloom using the new method. Levels of both blossom blight pathogens recovered from mature flowers remained well below 15% in southern Alberta. By contrast, recovery rates ranged from 50 to 90% in the Peace River region. The new technique for detecting *B. cinerea* worked so well that data collected by alfalfa growers was judged to be reliable enough to be combined with observations from Saskatchewan and Manitoba in a report that was published in the *Canadian Plant Disease Survey*.

Testing fungicides for alfalfa blossom blight control

Results from the survey were used to select two fields, one near Rosemary in southern Alberta and the other near Eaglesham in the Peace River region, for testing new fungicides. Two fungicides, Benlate and Bravo, were applied by air to four plot replicates, each 2 ha in area, in the south and three fungicides, Benlate, Bravo and Ronilan, with a ground sprayer to 0.75 ha plots in the north. Disease levels were so low in the south that sprays had no effect on recovery rates for either pathogen or on seed yield at harvest. Fungicides did, however, reduce disease levels on mature flowers in the north.

Evaluating cultivar resistance to alfalfa blossom blight in the field

Seventeen alfalfa cultivars were planted in a four-replicate, randomized complete block trial at the McLeod farm at CDCS. In addition to this, arrangements were made to take samples from twenty-five more cultivars and advanced breeding lines in the Peace River region at Beaverlodge and Fahler. Conditions were so dry and disease levels so low in southern Alberta that no significant data were collected in 1997. Observations from both sites in the Peace River region showed that levels of infection varied from one cultivar to the next in spite of the fact that each was exposed to the same level of inoculum and microclimate.

Laboratory and Greenhouse Trials

Evaluating cultivar resistance to two alfalfa blossom blight pathogens in the greenhouse

The seventeen alfalfa cultivars that were tested in the field at the McLeod farm, were planted in the greenhouse and inoculated with *Sclerotinia sclerotiorum* or with *Botrytis cinerea* when they were in full bloom. Rates of recovery of each pathogen was recorded for each tissue sampled. Recovery rates were high for some cultivars and moderate to low for others. Mature flowers had much higher levels of infection than leaves or stems. The response of all tissues from each cultivar were similar, i.e. if recovery rates were high for flowers then they were also high for leaves and stems. The fact that cultivars responded differently to infection from *B. cinerea* and *S. sclerotiorum* in controlled conditions in the laboratory and in replicated field trials suggests that genetic resistance might be used in the future to help manage this disease.

Testing the pathogenicity of *Botrytis cinerea* on common weeds

Twenty different weeds commonly found in or around alfalfa fields were transplanted into pots and, brought back to the laboratory where they were sprayed with suspensions of *B. cinerea* conidia. The pathogen was recovered from surface-sterilized mature flowers of most of these weeds. *Botrytis* was occasionally recovered from uninoculated flowers, stems and leaves of plants sprayed with distilled water alone. Clearly, some plants were infected before they were collected. Inoculation experiments although they do demonstrate the potential susceptibility of each weed, do not clearly demonstrate how frequently infection occurs in nature. A more detailed field study is required to determine which of these weeds are reservoirs of *B. cinerea* in the field.

Storage Trials

Testing imazethapyr, a new sprout inhibitor

Imazethapyr (Pursuit) was applied at four rates (0, 1.0, 2.5 and 5.0 g ai/l) in a spray volume of 1L/tonne to four 20 kg lots of commercially grown Russet Burbank potatoes. Sprayed potatoes were then put into a controlled environmental storage (CES) room at 9°C and observed every two months. Potatoes in the control treatment had such long sprouts that they were completely withered twelve months later. By contrast, treated potatoes showed almost no evidence of sprouting. Preliminary findings suggest that imazethapyr could be used as an alternative to Sprout-Nip (CIPC) or maleic hydrazide. Preliminary results look promising; however, imazethapyr still needs to be tested in typical commercial conditions on a range of cultivars before reliable guidelines can be developed.

Consortium storage trial for processing quality and disease resistance

Thirteen standard cultivars and twenty-one advanced breeding lines from the Prairie Potato Breeding Program were harvested then transported to Brooks for post-harvest tests. Half of these potatoes were loaded into CES rooms with stable storage conditions at 6°, 8° or 10°C. Samples were taken from each of the three stable CES rooms every two months to determine effects of temperature on chip, french fry, baking and boiling colour and texture. To date, potatoes in the 8° and 10°C CES rooms have retained good processing quality, however, quality of potatoes from most of the test lines degenerated quickly at 6°C.

The other half were put into a CES room at 8°C with fluctuating levels of temperature and humidity. Tubers in the unstable 8°C CES room were subjected to stressful conditions to see how resistant they were to diseases that become more severe in storage after harvest, e.g. late blight, leak, silver scurf and pink, dry and soft rot decay. Results for disease resistance screening have not been analysed yet.

Effect of cultivar and treatment on silver scurf infection on potato in storage after harvest

Half tonne pallet boxes of commercial potatoes were harvested, then loaded either into a cool-down CES treatment rooms in which temperature decreased at a steady rate of 0.016°C per hour (1.7°C per week) or into a CES room in which temperature was lowered in incremental steps of 1.7°C once each week over a three to four hour period. After all of the field heat had been removed, tubers from each cool-down room were divided into three equal lots. One third of the potatoes were put into a long-term room with low levels of relative humidity (80-85%) and two thirds into one of two rooms with high levels of humidity (90-95%).

Temperature and humidity levels were steadily maintained in the room with low levels of relative humidity and in one of the rooms with high relative humidity. The temperature was programmed to fluctuate in the second high humidity room. Preliminary results showed that the highest levels of disease were found in the CES room with unstable conditions. Lowering humidity levels from 95% to 85% did not reduce levels of silver scurf. Results are preliminary, however, and need to be verified using data from three seasons.

Testing the efficacy of azoxystrobin on stored potatoes

Azoxystrobin was applied at five rates (0, 1.5, 3.0, 4.5 and 6.0 g ai/l) in a spray volume of 1 L/t to eight 50 kg lots of commercially grown Norchip and Russet Burbank potatoes. Half of the sprayed potatoes were put into a CES room with stable conditions and the other half into a CES room with fluctuating conditions. Tubers will be evaluated later in the storage season to see how well the fungicide limited the development of dry rot and silver scurf after harvest.

Testing the efficacy of metalaxyl as a control for four storage diseases

The Post-Harvest Technology Program initiated a cross-Canada storage trial in cooperation with Novartis Canada in 1997. Small plots of potatoes were planted in four replicate randomized complete blocks in six different provinces, i.e. Prince Edward Island, Quebec, Ontario, Manitoba, Alberta and British Columbia. During the summer small plots at each locations were sprayed either with Ridomil MZ + Dithane, Ridomil Gold + Dithane, Tattoo-C + Dithane, Ridomil Gold + Bravo, Bravo, Dithane or water three times and then as often as needed to control early and late blight. Potatoes from each small plot were harvested and shipped to Brooks. Half of the potatoes from each replicate were loaded into a CES room with steady conditions. The other half were put into a CES room with fluctuating conditions. Baseline set points for both of the CES rooms were 8 °C and 95% for relative humidity. Two months later potatoes were removed from the first CES room, washed, surface sterilized and allowed to dry. Then each tuber was wounded and inoculated either with *Pythium ultimum*, the leak pathogen, or with *Phytophthora erythroseptica*, the pink rot pathogen. Levels of each disease from each inoculated tuber were recorded. Results were subjected to standard analysis of variance and mean tests. Potatoes stored in the second CES room were examined carefully every two months and levels of late blight, dry and soft rot decay on them recorded. Data from the second CES room were analysed as described previously.

Preliminary data from potatoes grown and sprayed in PEI and Quebec showed that the application of Ridomil Gold + Bravo significantly increased tuber resistance to infection from leak or pink rot. In addition to this, levels of late blight and storage decay were significantly lower on Ontario and Quebec potatoes that received this treatment than on potatoes treated with any other combination of fungicides.

Testing the efficacy of fludioxonil, a new seed piece treatment for potato

The program initiated a second cross-Canada storage trial in 1997. In this trial, small plots of potatoes were planted in four replicate randomized complete blocks in three provinces, i.e. Prince Edward Island, Ontario and Alberta, after being coated with 0.33 % or 0.5% fludioxonil, 10% thiophanate-methyl, 80% mancozeb, talcum powder or without being treated first. Potatoes from all small plots were harvested, shipped to Brooks and loaded into an 8 °C CES storage room with fluctuating conditions. Levels of silver scurf and dry-rot were evaluated at harvest and then again mid-way through and at the end of the storage season. Results from this trial are incomplete at this time.

Testing disinfectants as alternative control agents for diseases on potato in storage

Six, ½ tonne pallet boxes of commercially grown Norchip, Russet Burbank and SL1625 potatoes were harvested in the fall of 1995 and 1996, then three boxes of each were loaded into two CES rooms. Water vapour containing 50 ppm of dissolved hydrogen peroxide was injected into one CES room with a Gellert humidifier. Humidification was normal in the second. Unfortunately there were no differences in levels of diseases on

potatoes stored in the two CES rooms. Hydrogen peroxide is a powerful oxidant, so it may have been deactivated as mist circulated through the storage facility. It will be necessary to increase the concentration of hydrogen peroxide or use a disinfectant that is more stable chemically the next time the experiment is run.

Effect of bleach dip treatments on stored carrots

A storage trial was set up to determine how bleach dip treatments and post-harvest conditions affect the moisture, colour, sugar content, taste and level of disease of cellophane-bagged carrots. Caro-Choice, Eagle and Kamaran, were grown for the trial at CDCS, harvested mechanically into ½ tonne pallet boxes, and loaded in bulk into CES rooms at 2°C with levels of relative humidity at 95%. Carrots were removed from the pallet boxes, washed, dipped into 0, 0.01, 0.05, 0.1, 0.25, 0.5 0.75, 1.0, 10 or 100 ppm of sodium hypochlorite, dried and packaged into two one kilogram cellophane bags. Half of the carrots were stored at 2°C in a CES room with humid stable conditions and the other half in a CES room with unstable conditions. Levels of decay from sclerotinia white and botrytis grey moulds were much higher in the CES room with unstable conditions. Carrots in the CES room with steady conditions showed very little decay even after twelve months of storage. Preliminary results from the last two seasons indicate that dipping carrots into solutions of chlorine greater than 1% adversely affected taste, sugar content, colour and appearance. Results from two previous and this season's experiments will be analysed to determine which bleach concentration prevented storage decay the best.

Technology Transfer Services

Routine queries about potato and vegetable diseases and about storing potatoes, carrots and other garden vegetables were dealt with as they arose. Specific storage problems were investigated at individual grower's or processor's requests or when samples were taken for fungicide resistance testing. The post-harvest technology program received requests to assist in solving storage problems from several different Canadian provinces and from the United States. The program leader attended the Western Committee on Plant Diseases meetings where he gave a disease status report for potato production from across Canada. He also assisted the chairman in editing and updating the potato chapter for *Guidelines for the Control of Plant Diseases in Western Canada*.

Routine queries about alfalfa blossom blight and other alfalfa diseases were also answered as they arose. New blossom blight disease detection kits were prepared and given to alfalfa seed growers in both major growing regions of Alberta, i.e. southern Alberta and the Peace River region. Growers used these detection kits successfully in 1997. An on-farm-demonstration trial was set up at Rosemary to show growers in southern Alberta a range of blossom blight symptoms in typical field conditions and to demonstrate the economic potential of applying the fungicide benomyl (Benlate) to their fields. Two presentations were made at the 15th Annual Canadian Alfalfa Seed Conference. Results from disease resistance screening trials were presented at the Southern Alberta Irrigated Seed Growers Association Meetings.

Participation continues on the Alberta Potato Research Committee, and the Storage Committee of the Prairie Potato Council. The Post-Harvest Program leader served as the president of the Plant Pathology Society of Alberta (PPSA). The 18th annual meeting of the PPSA was held at CDC-South and Medicine Hat College's Brooks Campus from Nov. 17-19, 1997.

Soil and Water Agronomy Program

R.C. McKenzie and S.A. Woods

The soil and water agronomy program conducted research on water and fertilizer requirements of special crops, horticultural crops and irrigated forages. Some research projects were done cooperatively with staff from other programs at Crop Diversification Centre - South (CDCS) and other divisions of Alberta Agriculture, Food and Rural Development (AAFRD). Soil samples were analyzed by AAFRD's Soil and Crop Diagnostic Centre, Edmonton. Research funding was provided by the Alberta Agricultural Research Institute's (AARI) Farming for the Future and Matching Grants Research Programs, the Potato Growers of Alberta, Canada/Alberta Environmentally Sustainable Agriculture Agreement (CAESA), Concord Equipment, The Potash and Phosphate Institute of Canada, Viridian, Westco, Cargill, DynAgra Fertilizers, Southern Agri Services and Old Dutch Foods.

Research Projects

Precision Farming

Precision farming systems to maximize profits and minimize environmental impacts

This integrated project, initiated in 1993, involved staff from the Agronomy Unit and Conservation and Development Branch of AAFRD, agricultural engineers from the Field Services Sector of AAFRD, engineers from the Geomatics Engineering Department of the University of Calgary, soil scientists from the University of Alberta, and staff from the Soil and Water Agronomy Program at CDCS. The project combined Global Positioning System (GPS) and Geographic Information System (GIS) technology to collect spatially located data. Sites used in the project were at Bow Island, Hussar, Stettler and Mundare. A yield monitor on a combine recorded output and was continuously positioned using two GPS receivers, one stationary and one on the combine. Wheat, barley and canola fields were yield monitored. From these data, a computer-generated yield map was developed for two to four fields from 1993 to 1996. This map was combined with other information, such as soil fertility, salinity or topography to develop an input map. Fertilizer treatments were applied to three fields, starting in 1994, with a spreader equipped with a GPS receiver and able to change its rate of application on the go.

Results indicated that the soil fertility content distribution was positively skewed, i.e. the mean value was greater than the modal value. A fertilizer application is usually based on the mean value of a composite sample, which means that large areas of the field may receive less than optimum amounts of fertilizer. At two sites, large portions of the field were deficient in sulphur, but this was obscured by some areas having extremely high sulphur levels. For example, at Stettler, the mean sulphur value for 0-60 cm was 545 ppm, while the modal value was 14 ppm. Returns for grid sampling and site-specific applications were calculated. Comparisons with yield variability in the check strips indicated further benefits could be obtained from more intensive grid sampling. Site-specific applications of fertilizer produced higher yields than uniform applications.

Soil nitrogen was found to be closely correlated with soil salinity. A benefit of site-specific technology is that nutrient losses and environmental contamination can be reduced if fertilizer applications are reduced on areas that already have high levels of nutrients. A relationship between salinity and yield of barley was established. It agreed with previous results derived from hand sampling of irrigated barley.

Site-specific management of potatoes

This project commenced in 1996 and will continue until 1999/2000. The objectives are:

- to measure and map yield variability
- to determine the effects of soil type, landscape position, soil fertility, diseases and weeds on yield
- to determine the variability of preceding and subsequent crops, and to relate this to field variability and tuber production
- to measure the cost benefits and environmental influences of site-specific management
- to evaluate remote sensing and digital image analysis to detect nutrient deficiencies and diseases.

Two, 27 ha potato fields were monitored in detail. One was irrigated with a centre pivot and the other with a corner pivot. Soil texture was determined at 48 points and, at these points, rainfall, irrigation and soil moisture records were taken weekly and plant petiole samples were taken three times for nutrient analysis. Yield data and remote sensing imagery were also collected.

The project showed that soil texture, tissue nutrient content and the available soil moisture status of potato fields were quite variable. Tissue phosphorus, as well as nitrogen, declined rapidly during the growing season in portions of the potato fields. The potatoes were deficient in tissue potassium in early July, 1997, on both fields, but there was adequate potassium on both fields at the end of July and in August. Low soil temperature is known to reduce the uptake of potassium. In 1996, soil moisture was lower under the outer portions of the centre pivot and on the corners of the corner pivot system. In 1997, the centre pivot system was converted to a low pressure system and, as a result, water application was higher on the outer part of the system and lower near the centre.

Soil Fertility

Fertilizer requirement of irrigated alfalfa

In 1994, an experiment designed to determine the response to fertilizer application in irrigated alfalfa was begun. This project was jointly funded by the AARI Matching Grants Program, the Potash and Phosphate Institute of Canada, Westco Fertilizers and Sherritt Fertilizers, and with the cooperation of six alfalfa hay producers in southern Alberta. The object was to determine if six fields which tested low in soil phosphorus and adequate in tissue phosphorus would respond to phosphorus fertilization. Three fields, which were adequate in soil potassium and low in tissue potassium, were tested for a response to potassium application. Low rates of nitrogen were also tested on alfalfa. In 1996, four of the original six fields were taken out of production and three new fields, which were low in phosphorus and potassium, were added. The results indicated:

- Some fields showed a positive response to nitrogen, but it is not known how to predict which fields will respond.
- Broadcast phosphorus was equal to shallow-banded phosphorus.
- A combination of soil tests and tissue tests appeared to be the best way of measuring the need for phosphorus fertilizer.
- Potassium did not give a significant yield response.

Controlled-Release Fertilizers for Container-Grown Woody Plants

The soil and water agronomy program assisted the nursery crops program with this project. Three rates and four combinations of 8-9 month and 3-4 month, coated, slow-release fertilizers, along with a control treatment of a water-soluble fertilizer, were used. Four ornamental species were grown: Savin juniper *Juniperis sabina*, Alpine current *Ribes aplinum*, Dwarf Korean Lilac *Syringa meyeri*, and Coronation triumph potentilla *Potentilla fruiticose*. The results indicated that under Alberta growing conditions the use of controlled release fertilizers with quicker release times (i.e., 3-4 months) or in combination with fertilizers with longer release times are more effective for container growing of woody plants than fertilizers with longer

release periods alone. Fast growing deciduous species grew larger in response to increased N availability earlier in the growing season and to higher rates of N application.

For further details of this project, see the report in the nursery crops program section of the 1997 Annual Report.

Investigation of the growth of two species of field-grown trees at different nitrogen fertilizer rates

The soil and water agronomy program assisted the nursery crops program with this project as well. It received financial support from the AARI, Arrowhead Nurseries, Edmonton, and the Alberta Ornamental Plant Foundation. Field-grown plant material provides about $11.2 million in sales to Alberta growers. There is inadequate information about management of fertility to provide maximum growth and still avoid over fertilization which may cause dieback or winterkilling of trees.

Colorado blue spruce and green ash were planted in 1997 at Brooks and Edmonton and four rates of soil nitrogen were applied at each site. No significant differences in growth were observed in the first year.

For further details of this project, see the report in the nursery crops program section of the 1997 Annual Report.

Technology Transfer Services

Soil and water information was provided to a diverse audience through scientific papers, technical reports and research publications. Presentations were made at technical conferences and producer meetings and inquiries were answered through telephone contacts, office visits and correspondence.

The yield monitoring projects attracted a lot of attention from the media and various agricultural industries.

Presentations on this project were made at a number of meetings, and in agricultural publications. Information on crop tolerances to salinity and methods of measurement was provided to farmers, extension personnel and researchers. Manure management information was provided to AAFRD staff who were revising the Manure Management Code of Practise. Information on water use and protein content of various types of wheat was used in several publications.

Special Crops Program (Edmonton)

S. Blade and N. Clark

Alberta crop producers are interested in diversifying their production. One successful strategy is incorporating new crops into the farming system. The special crops programs in the New Crop Development Unit are dedicated to introducing new crops that will contribute to the long-term viability of agriculture in the province. Diversification can aid in improving crop rotations through inclusion of pulse crops, reduce risks due to price volatility in traditional crops, and expand opportunities for value-added processing.

The Special Crops Program at CDCN has been active in the identification and development of economically promising crops since 1995. Our focus has been on several categories of new crops, e.g. pulses, spices, alternate crops, herbs (medicinal, culinary and aromatic) and fibre crops. Within the pulses, field peas holds the highest priority for the program. In addition to initiating a pea breeding program at CDCN, program staff are working closely with other prairie breeding programs to ensure that producers can benefit from the rapid advancement of promising lines. Program staff participate in the Western Canadian Forage Pea Network and the Western Canadian Ascochyta Initiative. Agronomic activities include large-scale field trials testing rhizobial inoculant formulations and a collaborative trial testing field pea-barley silage cropping. Staff also are active in screening the newest lentil, chickpea and faba bean lines. In 1997, staff also assisted in testing the feasibility of solid-seeded dry bean production in central Alberta. Spice and alternative crop screening trials at several locations throughout Alberta identified potential candidates for further testing, e.g. caraway, coriander, borage and buckwheat. Medicinal plant screening trials at CDCN looked at 150 potential species that were assessed under local conditions for adaptation. The program has taken the lead in Alberta-based research on low-THC fibre hemp, which is evolving into a potential commercial crop due to the efforts of several collaborators in the province.

Research Projects

Early generation field pea screening

Following the planting of approximately 1000 microplots of early generation field pea lines in 1996, a selection of the best families was planted at two locations in 1997. A total of 312 entries, including multiple check cultivars Eiffel, Carneval and Carrera, were planted in two-replicate trials at Namao and Fairview, with the help of Paul LaFlamme, AAFRD, Grande Prairie. These lines were evaluated for flowering date, maturity, plant architecture, lodging and yield. A total of 34 lines representing a variety of green and yellow types, seed sizes, maturity outyielded the check lines when averaged over the two locations. It was also noted that pea lines were significantly influenced by location, implying that different characters were advantageous between the two sites.

Adaptation of field pea for Zone One ecologies

To assist in identifying useful parental material for the pea breeding program at CDCN, an experiment was initiated in 1996 and repeated in 1997 to investigate the response of 15 field pea cultivars to additional precipitation. These lines were irrigated to compare a low treatment (only seasonal rainfall) with medium (150% of seasonal rainfall) and high (200% of seasonal rainfall) precipitation levels. Data were collected on plant partitioning, i.e. weight of stems, branches, leaves and reproductive components at various times during the growing season. Lodging and yield data were also recorded. There were significant differences between precipitation treatments and between varieties for vine length/canopy height ratios, and a significant interac-

tion between precipitation treatments and cultivars for grain yield. Cultivars least affected by excess precipitation have been incorporated into the breeding program.

AAFC collaborative field pea screening

As part of the on-going collaboration with Dr. T. Warkentin, AAFC, Morden, MB staff assisted in growing two advanced yield trials at Wetaskiwin and Namao. The data from these two sites will be used to support the registration of new field pea lines from the AAFC program.

Lentil screening in Alberta

In collaboration with Dr. A. Vandenberg, University of Saskatchewan, Saskatoon, 24 advanced breeding lines from the Crop Development Centre were grown in replicated trials at Lakeland College, Vermilion. These included ascochyta-resistant replacements for both Laird and Eston, in addition to several new red-cotyledon lentils and some other niche lines (French greens, browns).

Faba bean screening in Alberta

Due to the tremendous ability of faba beans to fix nitrogen, the program is attempting to do a small amount of research on this crop. A set of the Western Faba Bean Co-op Trials was grown out. A set of lines collected from private companies and material obtained from Dr. J. Helm, AAFRD, Lacombe, AB, which originally was developed by Dr. W. Berkenkamp, AAFC, Lacombe was tested. Crosses of this material are being attempted by the program staff to achieve greater earliness and small seed size.

Evaluation of silage pea cultivars for grain and biomass yield

As the livestock population increases in Alberta, there is a large amount of interest in producing high quality silage. One method to do this is to include field pea in the barley silage system that many producers use now. In collaboration with Ken Lopetinsky, AAFRD, Barrhead, sites at CDCN and Barrhead were used to test 15 field pea lines as sole crops and as intercrops with Seebe barley. Data were collected on first and final biomass yield, as well as on silage forage analysis and final grain yield. Silage and grain yields were higher at CDCN due to higher levels of fertility. A number of the silage pea cultivars performed very well, including Arvica, Performance 4010 and Packer. Yields of Packer sole crop silage yields (combination of two cuts) was 14.1 tonnes/ha, in comparison to pure barley (same seeding rate as in the intercop) at 12.2 tonnes/ha. If protein yield/acre is considered, there was a significant advantage to including field pea in the silage mixture. At CDCN, Packer yielded approximately 2.4 tonnes of protein per hectare, in comparison to pure barley, which produced less than 1.5 tonnes of protein per hectare.

Testing new inoculant formulations for peas in north-central Alberta

In collaboration with Dr. George Clayton, AAFC, Lacombe, we continued to test new rhizobial inoculant formulations for field peas at Calahoo and Vegreville. These large field-scale plots were seeded with a ConservaPak No-Till drill. The experiment was a factorial, which tested inoculant formulation (non-inoculated check, liquid, peat powder and granular) and four rates of starter nitrogen (0, 20, 40 and 80 kg/ha). In 1997, Carneval peas were planted using these treatments. In addition, barley was replanted on the 1996 experimental sites to quantify effect of the 1996 pea treatments on 1997 barley productivity.

Private sector collaboration

Several private companies provided funding to obtain independent data regarding a range of cultivars and inputs associated with new crops in the province.

Province-wide special crops evaluation plots

In 1997, there were approximately 10 special crop evaluation trials in Alberta. One collaboration was with Zone 3 of the Alberta Pulse Growers Commission, which received On-Farm Demonstration assistance to evaluate 24 new crop types, at Namao and Barrhead. Of interest were the yields of Chinese broad bean (4346 kg/ha), fenugreek (1412 kg/ha) and the dry bean cultivar "Viva" (1156 kg/ha). These trials allowed us to gather information on the adaptation, disease/insect susceptibility and yield of many potential new crops.

Medicinal plant screening

At CDCN in 1997, approximately 150 species of medicinal, culinary and aromatic herbs were screened. Data were collected on plant development, height, biomass and overall adaptation. The first four-year ginseng harvest was done on small plots in October, 1997, with fresh weight yield equivalent of 10.0-11.1 tonnes/ha. A field trial testing the performance of *Echinacea angustifolia* at different densities and on ridges was conducted.

Evaluation of glabrous canaryseed

Annual canary grass, or more commonly canaryseed, is a significant crop in western Canada. Canada accounts for almost 75% of the world's production. In addition to Keet, which was originally selected from a USDA collection in Iran, a new hairless canary seed variety CDC Maria has been registered in western Canada. In tests at CDCN, CDC Maria yielded approximately 81% of the standard variety Keet.

Field testing of low-THC hemp in the black and dark brown soil zones of Alberta

Low-THC fibre hemp (*Cannabis sativa* L.) has been tested in Alberta over the past three years. This crop has the genetic potential to produce high levels of biomass (up to 17 t/ha) and seed (1350 kg/ha) in Alberta. Interesting results from research on planting arrangement and density indicated that additional research is required in a wide variety of agronomic and management issues. The Health Protection Branch has recently indicated its interest in looking at licensing commercial production of this crop in Canada. The economic potential of hemp is still unclear, even if regulatory hurdles to production are removed.

Technology Transfer Services

Program staff were called upon to answer numerous enquiries on a wide range of new crop opportunities relating to pulses, spices, medicinal plants and fibre crops. Staff contributed articles on crop diversification and species-specific topics to producer newsletters, industry periodicals and provincial newspapers. The interest in crop diversification resulted in several interviews with newspaper, radio and television media, which prompted further enquiries from the general public.

Due to the great demand for information about these

new crops, staff participated in a large number of courses, seminars and field tours. The Special Crops Field Day held at CDCN on August 7 was a tremendous success, with more than 250 participants. AAFRD Pulse and Special Crops Specialists secured planting materials for demonstrations across the province and sourcing technical information, which was then extended to clients. A new innovation was involvement in Ask The Expert and Agri-Ville electronic forums, which provided an opportunity for staff to interact directly with producers in a new and highly effective forum. Clients included producers, other AAFRD Units, universities, Agriculture and Agri-Food Canada, other provincial agriculture departments, applied research associations and agri-industry. An interesting component of the work was that many of the trials were done as researcher-managed, on-farm experiments, which allowed neighbors to view technological innovations in their own area.

Special Crops Program (Brooks)

R. Gaudiel, C. Wildschut, E. Russell and L. Ost

The special crops program is primarily responsible for the development of alternative and new crops for Alberta through applied research and technology transfer. This meets the ministry's goal towards crop diversification and competitiveness. The program also provides service to other departmental staff and to commodity organizations as consultants, through cooperative tests and demonstration plots, and by providing materials and advice to interested parties.

Detailed project results are presented in CDCS pamphlet 98-20, *Special Crops Cultivar Trials*.

Research Projects

Drybean cultivar evaluation and cultural practices

Thirteen yield tests with various drybean lines and varieties were conducted at Brooks and Bow Island under irrigated conditions, except for one dryland site at Brooks, to gather data for screening, registration and recommendation purposes. Field trials investigating the effects of *Rhizobium* inoculation and formulation at different levels of nitrogen and phosphorus fertilization on various varieties was done and a final report is being completed by Dr. R. H. McKenzie, Agronomy Unit, AAFRD, Lethbridge.

The growth and development of the bean plants early in the season were slow. However, warmer weather later in the season and a growing season longer than normal enabled most plants to reach maturity.

Several new varieties or lines were developed by the bean breeding programs in Lethbridge (Agriculture and Agri-food Canada) and in Saskatoon (Crop Development Centre) that were upright in growth habit and high yielding. Most were also as early or earlier maturing than the standard commercial varieties. Five new dry bean lines, consisting of three pintos, one Great northern and one manteca-type were recommended for varietal registration by the Prairie Registration Recommending Committee on Grain (PRRCG). The availability of these upright and early maturing varieties opens up the possibility of seeding beans in narrow rows, harvesting by straight combining and expanding beyond the present area of production.

Other pulse crop cultivar evaluations and cultural practices

Ten fieldpea cultivar trials were conducted at Brooks, Bow Island and Standard to evaluate lines and varieties for screening and regional adaptation purposes. The most promising new lines and varieties continued to come from European breeding programs. A number were relatively early maturing, semi-leafless and upright in growth habit. Five fieldpea lines, i.e. two yellow and three green-seeded types, were recommended for varietal registration by the PRRCG. They were higher yielding than the current standard varieties, had a higher protein content and were early maturing, with acceptable disease resistance and quality characteristics. In 1997, 19 sites in Alberta and the Peace region of B.C. were used in testing new registered fieldpea varieties. Some of the varieties that yielded better than the check variety, Carneval, were: Alfetta, Canis, Carrera, CPB Phantom, Eiffel, Grande, Narva, Profi and Tenor.

Different lines and registered varieties of other pulse crops, such as lentils, fababeans, chickpeas, soybeans and lathyrus, were again evaluated for registration and for regional adaptation. Most new lentil varieties continued to perform well in Alberta. A new line 512-2, which is similar in seed size to the standard variety Eston, but is more ascochyta resistant, was comparable in yield and may replace Eston in the future. Two other ascochyta-resistant varieties, CDC Matador and CDC Redwing, and the medium-seeded variety, CDC Richlea, were among the highest yielders. The low-tannin cultivars were still low yielding. The fababean line, NPZ 7051/93, was recommended for varietal registration by the PRRCG in early spring. A number of Kabuli- and Desi-type chickpea lines from the Crop Development Centre at Saskatoon were early enough to mature and yielded satisfactorily. Also, two Natto-type soybean lines from Agriculture and Agri-food Canada at Ottawa were able to mature, but yields were still lower than the standard, larger-seeded varieties. One Lathyrus or grass pea line - X87117 was recommended for registration by the PRRCG.

Other special crop cultivar evaluations and cultural practices

Several cultivars and lines of millet, mustard, safflower, and hybrids of sunflower and corn for grain and silage were evaluated for potential registration and regional adaptation. A few foxtail millet lines were early enough to mature. In 1997, the mustard varieties Ochre, AC Pennant and Gisilba were the highest yielding of the yellow mustards, and AC Vulcan was the highest yielding of the brown mustards. The grain and silage corn tests at Brooks evaluated 25 and 28 hybrids, respectively. There were several early maturing, high-yielding grain corn hybrids. Average corn silage and grain yields were 19.0 and 9.7 t/ha, respectively. The confectionery sunflower hybrids D151, 6946 and XF962 were the highest yielding amongst 18 entries tested at Bow Island.

New crop adaptability

Different lines and selections of grain amaranth, fenugreek and stevia were evaluated for adaptability by measuring maturity and yield at Brooks. The potential of squash for confectionery seed production was assessed at Bow Island using the varieties Howard Autumn, NK530 and Golden Delicious. Howard Autumn produced seed yields and quality that were close to being commercially acceptable. There were a few lines of grain amaranth that were early enough to mature properly in Alberta. A few selections of fenugreek yielded as well and matured as early as the standard variety. A number of stevia selections continued to produce satisfactory leaf yield. Further large-scale testing is needed to determine the commercial viability of this crop in Alberta.

Adaptability, cultivar development and agronomic studies of essential oil, spice and health promoting crops

The purpose of this project was to evaluate promising lines and selections, to develop management practices for selected spice and aromatic crops, and to evaluate the adaptability of various lines/selections of other health-promoting plants, particularly ginseng.

Studies on the effect of different types of planting stocks on peppermint and spearmint performance and the tolerance of several field crop species planted in terbacil (a persistent mint herbicide) treated soil was continued at Brooks. Preliminary results of the trial evaluating the effect of using different planting stocks on the biomass and essential oil yields of both mint types did not appear to show significant differences. Crops that appeared to have greater tolerance to terbacil residues were field peas, followed by corn. Canola was the most susceptible. Plowing a field previously treated with terbacil helped reduce the damaging effect of the herbicide.

Twenty-four advanced selections of high methyl cinnamate basil were directly seeded in the field and managed to simulate commercial production. These selections were individually harvested and steam distilled. A few lines were identified to have higher essential oil yields and will be selected for further seed increases and larger field testing in the future.

This was the first year of observing the emergence and growth of ginseng seeded in the fall of 1996 at Brooks. The number of plants emerging from beds covered with either 5 or 10 cm of straw were similar. However, when the beds were permanently mulched with 15 cm of straw, emergence was reduced. If the straw mulch was removed early in spring, the number of plants that emerged was similar for all the bed, irrespective of the depth of straw cover. Covering with a thermal blanket a bed already covered with 5 cm of straw enhanced seedling emergence in the spring. Unfortunately, seedlings that emerged early were damaged by a late spring frost. Date of straw removal affected the date of emergence of ginseng, but not the total number of plants that emerged. The earlier the straw was removed, the earlier the seedlings emerged. Treating seeds with formaldehyde appeared to slightly affect germination and emergence. The Goldenseal rootlets planted in the same beds in the fall emerged fairly well early in spring, whereas the oriental ginseng had very poor emergence. No noticeable visual differences were apparent between beds of ginseng given different fertility treatments. Most often, symptoms of nutritional disorders show up during the second year of growth.

Most of the approximately 24 species of perennial medicinal plants established in 1996 for adaptability evaluation survived the winter. Aster yellows disease was seen in valerian and echinacea. Another 48 perennial and 42 annual medicinal plants were established in 1997 and biomass data were taken. Plant population and direct field seeding vs transplanting trials with *Echinacea purpurea* and *Echinacea angustifolia* were established. Plant biomass data and samples were taken and certain plants were or will be distilled for essential oils.

A number of ginseng farms in southern and central Alberta were visited and surveyed with Dr. Kan-Fa Chang for diseases and general condition of the gardens. Root samples were taken in certain gardens to estimate potential root yield. A number of the gardens have shown that potential yields of 2000-3000 kg/ha of dried roots are possible in Alberta. The results of disease observations are presented in the report of the plant pathology program.

Technology Transfer Services

Program staff continued to answer numerous inquiries on the production of special crops, particularly on herb, spice and essential oil crops and on hemp. Information was contributed on special crops to producer newsletters and the news media. The special crop varietal performance factsheet was updated.

The program staff participated in courses, seminars and field tours. Demonstration plots of various special crops, including herbs, spices, essential oil, medicinal plants and other new crops, at Brooks and Bow Island were visited by a large number of interested individuals and groups.

Extension staff and other interested parties were provided with planting materials for demonstration and field testing. Program staff continued to help herb, essential oil and spice producers evaluate new crops and to develop their agronomic practices. The Alberta Regional Special Crops Varietal Test was coordinated with a report prepared and distributed. The performance data of registered varieties of fieldpeas, drybeans, lentils, fababeans and mustard was prepared and distributed to cooperators, specialists, growers and agri-businesses

Special Crops Program (Lacombe)

R. Park

The special crops program at the Field Crop Development Centre, Lacombe, is responsible for special crops technology transfer and for partnering with associated government and private sector groups for the advancement of the special crops industry in Alberta. The program also participates in a small agronomy and varietal assessment program, concentrated primarily on grain legumes. In 1997, applied research projects were conducted at four sites in north central Alberta.

Research Projects

Field pea individual seed growth rate test (ISGR)

This test was established to study the effect of controlled flower abortion on pea with the possibility of proving that the loss of flowers on pea plants during full bloom may result in increased seed size. Alberta field pea producers rely almost exclusively on imported European varieties for commercial production. As a rule, the seed size in these imported cultivars has increased during pedigreed multiplication, thus discouraging pea production, in some cases, as well as increasing planting costs. The study showed encouraging results and will be continued and expanded to two additional locations.

Field pea seeding rate test

Seeding rate studies were conducted to measure yield and tillering of two varieties seeded at four different rates. This experiment showed that seeding to achieve seven viable plants per sq. ft. provided for optimum yield. This trial has now been conducted for two years with a total of six station years of data. The results are conclusive enough to warrant publication and to be presented to Alberta field pea producers.

Green field pea bleaching test

This program partnered with AAFRD Pulse and Special Crop Specialist Ken Lopetinsky in a study of seed bleaching in green peas in 1997, which was the third year for this project. It was conducted at three north central sites and one south central Alberta site. The study was established to measure bleaching of 10 green pea varieties treated three different ways. One treatment was desiccated at the proper stage of maturity, another treatment was harvested four weeks later without a desiccant, and a third was harvested very late at the south central location. Analysis of the treatments concentrated primarily on colour quality of the 10 varieties over the three treatments. The results of the three years of testing proved that harvest management is crucial for preserving seed colour in green peas. These results will be published and will be valuable, as well, in technology transfer activities with producers.

Technology Transfer Services

The Program Leader continued to receive and answer numerous inquiries on varieties, production and marketing of various special crops. Articles were written for producer newsletters, magazines and for the news media. The Leader participated in numerous courses, seminars and field tours, and provided AAFRD Pulse and Special Crops Specialists with information as requested. He also participated in the formal training of these Specialists. Six special crops production manuscripts, which were written by the Pulse and Special Crops Specialists, were edited and submitted for publication through AAFRD's Publication Branch.

Weed Science Program

R. Esau and B. Kruger

The major emphasis of this program is to develop new weed control systems and improve existing ones for vegetable, potato, fruit, nursery, pulse and special crops. Commercial and experimental herbicides, as well as different crop management techniques, are evaluated to accomplish this objective. A second objective is to determine safe recropping intervals for potato and special crops following the use of soil-persistent herbicides. Weed control information is provided to commercial growers by phone, farm visits and workshops.

Research Projects

Weed control in vegetable crops

Onion - This crop is a weak competitor against weeds and requires a preemergent or early postemergent herbicide with good residual activity. In previous years, onion has shown excellent tolerance to pendimethalin (Prowl) applied postemergence. Its use in dry bulb onion crops received registration in 1997. One trial which included pendimethalin along with other herbicides was conducted to develop an effective weed control program. Pendimethalin at 1.1 kg ai/ha mixed with bromoxynil at 0.10 kg ai/ha, applied at the flag-leaf stage of onion, was followed by sprays of oxyfluorfen at 0.06 kg ai/ha and later by bromoxynil + seth-oxydim + Merge at the two-leaf stage. This weed control program reduced yields for Tarmagon onion, but not for Norstar. One single application of a herbicide mix does not adequately control weeds in onion crops.

Squash and cucumber - Devrinol received minor use registration for use in pumpkin and squash in 1997. To provide control of a wider spectrum of weeds, a micro-encapsulated formulation of clomazone (Merit) was tested in acorn and zucchini squash and in cucumber. Zucchini and acorn squash were mostly unaffected by clomazone, but cucumber was significantly injured. Total yields of these crops were unaffected by clomazone treatments. Clopyralid (Lontrel) severely injured all three crops, and bentazon (Basagran) injured the two squash crops but had only minor effect on cucumber.

Although pyridate (Lentagran) was tested previously for weed control in broccoli and cauliflower (minor use project #92-587, #92-588), it was not evaluated further because of its uncertain future.

Weed Control in Potato

Prism (rimsulfuron) was registered by the minor use program for use in irrigated potato crops. Although this herbicide suppressed growth of hairy nightshade, rimsulfuron by itself did not provide adequate control. Pendimethalin (Prowl) alone and in mixtures with either metribuzin (Sencor/Lexone) or linuron (Lorox/Afolan) were evaluated further. These mixtures provided excellent weed control. Total and marketable yields of cvs. Russet Burbank and Shepody potatoes for these two mixtures were equivalent to the weed-free check. The registration of Prowl is being held up by the moratorium placed on all dinitroaniline herbicides.

Herbicide carryover

Odyssey (AC 513,999), which is a 1:1 mixture of imazamox and imazethapyr, was applied at 30 g ai/ha to peas in 1996. Soil residues significantly affected canola and may also have affected potato yields in 1997, but flax yields were not reduced. These results require confirmation with further testing. Imazamox (AC 299,263) at 20 g ai/ha did not affect any of these crops; however, imazethapyr (Pursuit) at 50 g ai/ha reduced yields of all three test crops. A repeat of this trial was set up in an adjacent area where these three herbicides were applied to cv. Carneval peas. Seed yields from the three treatments were unaffected.

Weed control in special crops

Pulse Crops - The tolerance of four dry bean types (red mexican, pinto, great northern and pink) to Odyssey was evaluated. This product, which is 1:1 mixture of imazamox and imazethapyr, is usually less persistent in soil because the dosage of imazethapyr (Pursuit) in the mixture is lower than when it is applied alone. Odyssey was applied at 0, 30 and 60 g ai/ha with Merge adjuvant at 0.5% (v/v) when the crop was in the first trifoliate leaf stage. All bean varieties showed initial chlorosis, which was temporary. Great northern, pink and pinto bean seed yields were unaffected by Odyssey applied at 30 (X) and 60g (2X) ai/ha. Red Mexican bean yields were unaffected by the 2X rate, but for unknown reasons was significantly reduced by the X rate. Both rates of AC 513,999 controlled redroot pigweed, hairy nightshade and mustard.

Desi Chickpea - Weed control studies were initiated for desi chickpea in view of this crop's potential for the Dark Brown and Brown soil zones of the prairie region. Tolerance of desi chickpea (var. Myles) to ethalfluralin (Edge) pre-plant incorporated (PPI) at 0.84 kg ai/ha was excellent; however, some growth reduction was noted at the 2X rate. Application of ethalfluralin at either rate did not affect seed yields of chickpea. In a second test, ethalfluralin was applied to the entire plot area to evaluate post-emergent treatments of metribuzin (Sencor) and clethodim (Select). Chickpea tolerated metribuzin at 0.14 kg ai/ha; however, application at rates greater than 0.21 kg ai/ha reduced seed yields. Clethodim at the X and 2X rates had no effect on chickpea.

Herbs and Spices - Linuron (Afolan, Lorox) appears to have the best potential when used in combination with ethalfluralin (Edge) for broad-spectrum weed control in commercial dill. Ethalfluralin (PPI), followed by a postemergent application of linuron at 0.5 kg ai/ha with Assist oil concentrate, caused only minor crop injury and controlled yellow mustard, lamb's-quarters, redroot pigweed and hairy nightshade. Hairy nightshade was not adequately controlled by pre-emergence applications of linuron.

Fenugreek - A weed control program of ethalfluralin PPI followed by Odyssey controlled hairy nightshade, redroot pigweed, lamb's-quarters and barnyard grass in experimental plots of fenugreek. In this trial, Odyssey was applied at 15 and 30 g ai/ha plus Merge surfactant at the two-leaf stage of the crop. Crop yields for this sequential treatment were equal to the hand-weeded check. Ethalfluralin alone did not adequateiy control broadleaved weeds which resulted in reduced yield.

Coriander and caraway - A weed control trial was conducted with coriander underseeded with caraway to evaluate options for controlling various difficult-to-control weeds, including members of the Asteraceae

family. Clopyralid (Lontrel), rimsulfuron (Prism), oxyfluorfen (Goal) and metribuzin (Sencor) injured coriander and caraway severely. Injury was less severe in plots sprayed with MCPA-Na than those mentioned above. All treatments that caused significant crop injury delayed the maturity of coriander. Treatments that were safe on the crop included sethoxydim (Poast) + linuron (Afolan, Lorox) and linuron alone, with or without Assist surfactant.

Spearmint - A trial was conducted with spearmint to confirm the efficacy and crop tolerance to selected herbicide programs. Bromoxynil + MCPA (Buctril M) was applied at early post-emergence, i.e. when a few shoots of spearmint had emerged. Terbacil (Sinbar) alone or mixed with bentazon (Basagran) was applied one week later. The herbicide programs tested did not affect biomass yields; however, oil yields were all significantly reduced.

Canary grass - Quinclorac (Accord) was applied at 50, 100 and 200 g ai/ha to control green foxtail. In addition a number of herbicide mixtures with quinclorac at 100 g ai/ha were tested. Of these, the best results were obtained with bromoxynil + MCPA. Crop injury was minimal and yields were not affected. All rates of quinclorac provided good to complete control of green foxtail, although populations of this weed were low.

Weed control in forage seed crops

A final report for project FFF #93-0267 "Control of Grassy Weeds for Kentucky Bluegrass Seed (KBG) Production" was completed. Two new trials were established with KBG for minor use registration of a number of herbicides for broadleaved weed control. In addition, one trial area was seeded to perennial ryegrass for treatment in 1998.

Technology Transfer Services

Weed control recommendations were provided to growers by telephone, letter or office/farm visits, and presentations were made at producer and professional meetings. The Program Leader participated in a perennial ryegrass tour and a special crops field day at Brooks. Several informal tours of the research plots were conducted for interested growers and technical representatives of chemical companies. Presentations on weed seedling identification were made at a weed seminar in Brooks (March 17) and at a Nursery Growers Short Course in Surrey, B.C. (Dec. 3). The Weed Science Program continued to receive a significant number of enquiries concerning safe recropping intervals following the use of persistent herbicides for potato and vegetable crops. The Program Leader served as a member of the Special Crops Product Team. In October, the role of Key Communicator for the CDC South was transferred to Dr. C. L. Murray.

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- Tolerance of coriander to various herbicides
- Weed control in potatoes
- Weed control in onions
- Tolerance of acorn squash to selected herbicides
- Tolerance of slicing cucumbers to selected herbicides
- Tolerance of zucchini squash to selected herbicides
- Response of dry bean varieties to AC 513,999
- The effects of quinclorac on canaryseed alone and in tank mixes with broadleaved herbicides
- Effect of ethalfluralin alone and with metribuzin on desi chickpeas
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C.J. Wildschut, Dipl. Hort.	Special Crops, CDCS
S.A. Woods, B.Sc., M.Sc.	Soil and Water Agronomy, CDCS

Departures

J.A. Calderon, Dipl. Chem. Technol.	Food Science Technology, CDCS—Resignation, August 1997

Arrivals

L.R.J. Dowdell, B.Sc., M.Sc.	Food Science Technology, CDCS—November, 1997

Support Staff

S.J. Barkley, Dipl. Hort.	Information Officer/Librarian, CDCS
S.C. Day	Administrative Support (wages), CDCS
H. Ellis	Administrative Officer, CDCS
P. Fulton	Administrative Support, CDCN
L. I. Hansen	Officer Manager, CDCN
B.A. Humphreys	Receptionist/Timekeeper, CDCS
A. Moeller	Accountant, CDCS
C. Moore	Administrative Support, CDCN
V. Noel	Courier, CDCN
J.P. Petersen	Administrative Support/Human Resources, CDCS
M. Tanigami-Bunney	Administrative Support, CDCS

Departures

S. Peterson	CDCN—Long-Term Disability, April 1996

Farm and Site Operations Staff

N. Baronasky	Equipment Operator, CDCN
G. Dames	Welder, CDCN
G. Feth, Dipl. Hort.	Grounds Technologist, CDCS
B. Merkl	Mechanic, CDCS
S. Milne	Irrigation Technician, CDCN
B. Petherbridge	Maintenance Service Worker, CDCN
R. Williams	Senior Mechanic, CDCS
W. Wise	Farm Manager, CDCS

Departures

R. Marquardt	Chemical Applicator, CDCN—Long-Term Disability, October 1997

Meteorological Report

N.G. Seymour and T.T. Pheh

The Alberta Agriculture, Food and Rural Development's Crop Diversification Centre South (CDCS) operates two automated weather stations; one at the Centre southeast of Brooks and another at the substation southwest of Bow Island.

Brooks (CDCS)

Precipitation is measured with two instruments at the Brooks station. The Tipping Bucket Rain Gauge (TBRG) very accurate in reading rainfall to 0.2 mm is not reliable for recording snowfall. The Fischer-Porter Weighing Gauge (F&P) provides an accurate reading for snowfall equivalent.

The final spring frost of 1997 occurred on May 8 (-2.1°C). The first autumn frost was -2.9°C on September 19, giving a total of 134 frost-free days in 1997. This is higher than the 30-year average (1951-80) of 116 frost-free days (May 21 to September 15).

Table 6. 1997 Brooks (CDCS) Weather Data

	Temperatures (°C)								Precipitation (mm)			
	Extremes		Average				Means		1997			1961-90
	Max	Min	Max	30 yr av	Min	30 yr av	1997	30 yr av	TBRG		F&P	30 yr av
January	7.4	-39.2	-8.5	-6.9	-22.3	-23.6	-14.5	-12.5		n/a	3.7	18.4
February	11.5	-17.3	2.7	-2.4	-9.0	-13.9	-3.1	-8.2		n/a	0.7	11.9
March	19.2	-29.4	4.9	3.1	-9.0	-10.6	-2.0	-2.7		n/a	12.3	17.0
April	23.8	-12.2	12.0	12.2	-2.7	0.7	4.6	5.1		4.8	5.2	26.9
May	30.7	-2.1	21.5	18.7	5.2	3.5	13.4	11.4		41.6	42.4	39.1
June	29.6	5.7	23.4	23.0	9.8	9.8	16.6	15.9		38.6	37.4	65.4
July	32.1	5.2	26.6	25.9	11.0	11.8	18.8	18.3		11.6	9.4	38.0
August	36.8	5.4	26.6	25.2	10.6	10.9	18.6	17.5		42.8	35.5	36.3
September	31.7	-2.9	23.6	18.9	5.9	5.8	14.8	11.6		8.6	6.2	38.8
October	25.5	-10.2	12.5	13.6	-1.4	-1.4	5.5	6.3		3.4	2.0	15.8
November	19.6	-16.5	5.8	2.1	-7.7	-13.3	-0.9	-3.7		n/a	1.5	14.9
December	15.2	-18.2	3.8	-4.6	-9.1	-21.3	-2.6	-10.3		n/a	0.7	18.4
Average	23.6	-11.0	12.9	10.7	-1.6	-2.6	5.8	4.1	Tot.	n/a	157	341

Bow Island (Sub-station)

The last recorded frost was -1.2°C on May 19 and the first autumn frost (-0.9°C) occurred on September 19, for a total of 123 frost-free days in 1997, 2 days less than the 30-year average (1951-80) growing season at Bow Island of 125 days (May 17 to September 20).

It is important to note that precipitation is only measured with a tipping Bucket Rain Gage which is unreliable during the winter months.

Table 7. 1997 Bow Island Weather Data

	Temperatures (°C)								Precipitation (mm)		
	Extremes		Average				Means		1997		1961-90
	Max	Min	Max	30 yr av	Min	30 yr av	1997	30 yr av		TBRG	30 yr av
January	5.9	-43.5	-7.9	-5.2	-20.1	-15.9	-14.0	-10.6		5.8	18.6
February	11.9	-11.9	2.4	-6.3	-10.8	-11.7	-1.9	-6.3		2.3	11.3
March	16.3	-26.5	3.8	4.7	-7.1	-6.6	-1.6	-0.9		7.1	13.1
April	20.4	-11.8	10.2	12.5	-3.1	0.2	3.6	6.6		7.1	34.2
May	27.6	-1.2	16.8	19.2	5.1	5.5	10.9	12.4		37.1	44.9
June	28.1	5.5	22.2	24.4	9.7	10.7	15.9	17.6		48.8	69.8
July	30.2	6.2	25.0	27.6	10.2	12.1	17.6	19.7		4.3	30.9
August	35.5	2.9	25.9	27.1	10.4	11.9	18.2	19.6		26.2	32.4
September	31.4	-0.9	22.9	20.2	7.1	5.6	15.0	12.9		12.2	30.4
October	24.2	-8.0	13.0	15.0	0.4	0.5	6.7	7.6		4.3	12.3
November	20.2	-13.8	5.1	4.7	-6.4	-6.6	-0.6	-1.0		3.3	12.8
December	15.4	-16.3	3.3	-2.8	-8.3	-13.0	-2.5	-7.9		0.5	19.0
Average	22.3	-9.9	11.9	12.2	-1.1	-0.6	5.6	5.8	Tot.	159	330

Edmonton (CDCN)

Table 8. 1997 Edmonton (CDCN) Weather Data

	Temperatures °C					Precipitation	
	Extremes		Average		Means		
	Max	Min	Max	Min	1997	Snow (cm)	Rain (mm)
January	7.3	-43.2	-9.7	-22.8	-16.2	5.3	2.0
February	12.1	-18.1	0.87	-11.7	-5.4	5	
March	14.69	-31.02	-0.26	-12.56	-6.41	22.6	
April	19.87	-16.68	7.83	-4.23	1.8		3.56
May	26.39	-2.45	16.51	4.63	10.57	12.4	43.0
June	25.5	3.5	20.4	9.5	14.95		148.8
July	30.86	6.64	23.05	10.55	16.8		63.5
August	32.63	4.87	22.68	0.45	16.07		55.5
September	28.41	-0.73	18.86	6.2	12.53		77.8
October	19.58	-8.45	8.32	-.74	3.79		33.9
November	14.15	-13.99	3.2	-7.39	-2.1	2.5	3.0
December	13.15	-18.25	2.07	-7.95	-2.94	3.6	0.8
Averages	20.39	-11.48	9.49	-2.25	3.62	8.57	43.19

Heat units at CDCN calculated from last to first killing frost.

May	177.44
June	298.08
July	365.79
August	343.03
September	228.57
October	34.87
1997 Total	**1,447.78**

Last killing frost — May 2, 1997

First killing frost — October 7, 1997

Killing frost is taken as minus 2°C

Base temperature is 5°C